PRELIMINARY REPORT ON ICHTHYOPLANKTON COLLECTED IN MANTA (SURFACE) NET TOWS ON MARINE MAMMAL SURVEYS IN THE EASTERN TROPICAL PACIFIC: 1987-2000

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ABSTRACT

Data used in these analyses were collected during four years of the Monitoring of Porpoise Stocks (MOPS: 1987 - 1990), three years of *Stenella* Abundance Research (STAR: 1998 - 2000), and one year of Population of *Delphinus* stocks (PODS: 1992) projects. Larval fish (and other plankton) were collected using Manta (surface) net tows conducted during 1,434 nightly stations. In the laboratory, post-cruises, larval fishes were removed from all net tow samples, identified to the lowest possible taxonomic group, and counted. Counts were converted to density for further analysis. A total of 721,257 fish eggs and 31,508 fish larvae distributed among 314 taxonomic categories were represented in this data set. The fish larvae included 178 species, 78 genera, 5 subfamilies, 48 families, and 3 orders. Recurrent group analysis and ranked lists of occurrence and abundance of fish larvae revealed two primary recurrent groups and 17 taxa that were most likely to show the effects of environmental change. Examination of variation in occurrence, abundance, and distribution of these key taxa revealed no consistent temporal trends. Highest densities of coastal taxa were generally concentrated in upwelling regions along the Mexican and northern Central American coast, whereas highest densities of oceanic taxa were generally concentrated offshore of this region, usually to the northwest of the highly productive Costa Rica Dome. Abundance of key shorefish taxa was generally higher in PODS and STAR survey years as compared with MOPS, however this pattern may have resulted from the increased nearshore sampling effort on the PODS and STAR surveys. Offshore taxa exhibited no such temporal trends.

INTRODUCTION

This is a preliminary report of ichthyoplankton catches from Manta (surface) net tows taken on eight Marine Mammal surveys to the Eastern Tropical Pacific (ETP) from 1987 to 2000. In addition to monitoring the abundance and distribution of dolphin stocks, a primary objective of these surveys was to determine the relationship between environmental variables and dolphin population trends. Cruise protocol for each survey vessel called for a Manta tow to be taken at night in conjunction with the evening oceanographic measurements. Manta tows were taken on all surveys except the first MOPS survey in 1986. An oblique bongo tow was added to the station protocol on SPAM1998, STAR1999, and STAR2000 but identification of the ichthyoplankton from those samples has not been completed and they are not included in this report.

The eight surveys produced a total of 1434 Manta tows. To permit regional comparisons, we divided the overall survey area into 11 regions, based on 15˚squares (Figures 1and 2). Regional sampling effort varied considerably among the eight surveys and between the 1987–92 and 1998–2000 survey periods (Table 1; Figures 1 –3); however, the greater part of the ETP was covered in all years except 1992, when sampling essentially was limited to region 3. Station, tow, and catches of fish eggs and larvae and juveniles are published in a series of data reports: 1987 survey (Moser et al. 2000); 1988 (Ambrose et al. 2000); 1989 (Charter et al. 2000); 1990 (Sandknop et al. 2000); 1992 (Watson et al. 2000). Data reports for the surveys in 1998, 1999, and 2000 are in preparation: 1998 (Ambrose et al., in prep.); 1999 (Watson et al., in prep.); 2000 (Ambrose et al., in prep.)

An independent scientific peer review of this work was administered by the Center for Independent Experts located at the University of Miami. Responses to reviewer's comments can be found in Appendix A.

SAMPLING GEAR AND METHODS

The Manta net used on the ETP surveys is identical to the net used on California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises and is a modified version of the net originally designed by Brown and Cheng (1981). It consists of a rectangular mouth 15.5 cm deep and 86 cm wide attached to a frame that supports square lateral extensions covered with plywood and urethane foam. These extensions stabilize the net when it is towed and keep the top of the net at the sea surface. The net is constructed of 0.505 mm nylon mesh. The towing bridle is asymmetrical with one side longer than the other; when the net is towed this bridle arrangement forces the mouth away from the ship at a slight angle. A General Oceanics flowmeter was suspended across the center of the net mouth to measure the amount of water filtered during each tow. On the *Jordan*, net tows were initiated by attaching the tow line from the Manta bridle to the hydrographic wire above a 34 kg weight and then lowering the hydrographic wire so that the tow line was slightly below the surface. On the *McArthur* the net was towed from a boom on the starboard side of the ship, with the tow line from the bridle attached to the end of the hydrographic wire. The net was towed at a ship speed of 1.0–2.0 knots for 15 minutes. Samples were preserved in 5% buffered formalin and returned to the plankton sorting laboratory at the Southwest Fisheries Science Center (SWFSC) at the end of the cruise.

Sample sorting involved the removal of all ichthyoplankton from each sample; some samples also contained limited numbers of juvenile, and occasionally adult, stages of fishes which also were removed and bottled separately in 3% formalin. All specimens of *Halobates*, a marine insect, were removed from the 1999 and 2000 samples, bottled separately, and given to Dr. Lanna Cheng (Scripps Institution of Oceanography) for analysis. Constituent ichthyoplankton and juvenile fishes in the samples were identified and counted by D. A. Ambrose, S. R. Charter, E. M. Sandknop, and W. Watson. Early ontogenetic stages of fishes are difficult to identify and this is further complicated by the large number and diversity of species which contribute to the ichthyoplankton in the ETP. Most identifications were based on descriptions of ontogenetic series of fishes in an identification guide to early stages of fishes in the California Current and adjacent regions (Moser 1996). Larval specimens that could not be identified with the guide were identified by establishing ontogenetic series on the basis of morphology, meristics, and pigmentation, and then linking these series through overlapping features to known metamorphic, juvenile, or adult stages (Powles and Markle 1984). Fischer et al. (1995) was a primary source of information on distribution and taxonomy of adult fishes of the ETP. Except for damaged specimens, a large proportion of the larvae and most juvenile/adults taken in these tows could be identified to species. The types of larvae most difficult to identify were those of tropical shorefishes (e.g., Sciaenidae, Gerreidae) but most oceanic fishes could be identified to species or at least to genus. The count data were converted to number per unit volume (number per 100 m^3

of water filtered) prior to abundance analysis.

A useful method of revealing the assemblages formed by this large array of taxa is to examine their degree of co-occurrence. Recurrent group analysis (Fager 1957, 1963) defines groups of taxa that occur together frequently and thus share a common environment. Two procedures are used: first an index of affinity (program name AFFINITY) is calculated for each pair of taxa that ever occur together and then taxa are formed into groups (program name REGROUP) using a chosen minimum affinity index (0.2 in this study). The category "group member" is supplemented by the term "associate" for taxa that have significant affinity indices with one or more but not all members in one or more of the groups. We used recurrent group analysis to identify the principal taxa to be examined for annual variation in distribution and abundance. Distribution maps and graphs of average annual abundance were prepared for 17 taxa.

RESULTS

Recurrent Group Analysis

The 1,434 Manta tows produced a total of 721,257 fish eggs and 31,508 larvae distributed among 314 categories (including the unidentified and disintegrated categories). These included: 178 species, 78 genera, 5 subfamilies, 48 families, and 3 orders (Tables 2 and 3). Recurrent group analysis run at a critical affinity index of 0.2 produced eight recurrent groups: two broadly interconnected groups with six and four taxa each, two groups with three taxa each, and four two-taxon groups (Table 4). One of the two large groups is made up of primarily coastal species and the other consists of mainly oceanic species. In the coastal group (POLYDACTYLUS) are larvae of the flyingfish genus *Prognichthys*, and five perciform taxa, blue bobo *Polydactylus approximans*, the mojarra family Gerreidae, the mullet genus *Mugil*, green jack *Caranx caballus*, and the bullet tuna genus *Auxis* (Figure 4). The offshore group (OXYPORHAMPHUS), equally phylogenetically diverse, is made up of the highly abundant stomiiform species, Panama lightfish *Vinciguerria lucetia*, shortwing flyingfish *Oxyporhamphus micropterus*, a nomeid *Cubiceps pauciradiatus*, and pompano dolphinfish *Coryphaena equiselis* (Figure 4).The three-member groups and one of the two-member groups are coastal in distribution and the remaining two-member groups have oceanic distributions. The coastal group OPISTHONEMA, formed by the thread herrings (*Opisthonema* spp.), the grunt family Haemulidae, and the croaker family Sciaenidae is strongly connected to POLYDACTYLUS, with *Opisthonema* spp. sharing critical affinities with five of the six species in POLYDACTYLUS (Table 4). The number of members per tow for the POLYDACTYLUS group was highest in the region off Cabo Corrientes, Mexico, northern Central America, and in several years in the Gulf of Panama region (Figure 5). The number of members per tow also was relatively high off Colombia and Eduador in 2000. Typically, members were absent in offshore tows or those tows contained a single member. Members per tow of the OXYPORHAMPHUS group tended to be highest in the same general geographic regions as POLYDACTYLUS but tows with relatively high numbers of members occurred farther offshore than in POLYDACTYLUS and tows with relatively high numbers of OXYPORHAMPHUS members were found in various oceanic regions of the ETP (Figure 6). Spatial distributions of the number of group members per tow for the two time periods (1987–90 vs. 1998–2000) showed some difference in POLYDACTYLUS but no obvious difference in OXYPORHAMPHUS (Figures 5 and 6). Average numbers of POLYDACTYLUS group members per tow were generally higher in 1998–2000 compared with 1987–90 (Figure 7). Moreover, tows with relatively high numbers of POLYDACTYLUS members per tow were restricted to central America and southern Mexico during 1987–90 but occurred along the entire coastal region of the ETP during 1998–2000. Average numbers of group members per tow was distinctly higher for POLYDACTYLUS during 1998–2000 compared with 1987–90, whereas average group membership in OXYPORHAMPHUS was similar between these two periods. Average numbers of member taxa per tow was uniquely high in 1992 for both groups (Figure 7).

Occurrence and Abundance

Ranked lists of overall occurrence and abundance can be useful in selecting taxa whose population variations may reveal environment change. *Vinciguerria lucetia* was clearly the most ubiquitous and abundant larval taxon overall in the ETP surveys, with nearly double the larval counts of the second and third ranking taxa (Table 3). Moreover, *V. lucetia* ranked first in average abundance in 7 of the 11 survey regions and second in two others (Tables 5 and 6). *Opisthonema* spp. larvae ranked second in overall larval count (Table 3) but only eighteenth in occurrence (Table 2), reflecting the patchy nature of the samples of this nearshore taxon. This is further shown by the fact that *Opisthonema* spp. larvae were first in overall ranking only in region 3 and second only in region 1 (Tables 5 and 6). *Oxyporhamphus micropterus* larvae ranked second overall in occurrence and third in larval count (Tables 2 and 3), and were among the five highest ranking taxa in average abundance in 7 of the 11 regions (Table 6). *Auxis* spp. larvae ranked fourth both in occurrence and total larval count (Tables 2 and 3) and were among the five highest ranking taxa in average abundance in 7 of the 11 regions (Table 6).

Recurrent group analysis is a robust method of detecting important groups of co-occurring taxa within larval fish assemblages and identifying indicator taxa in order to examine temporal and spatial variations in abundance and relate them to environmental shifts (Moser et al. 1987; Smith and Moser 1988). For each of the ETP survey years, contour plots of average abundance (larvae per 100 m^3) are presented for key taxa identified by recurrent group analysis. Also presented for each taxon are histograms of average occurrence (proportion of positive samples) and abundance (larvae/100 m^3). Average abundance of total fish larvae was lower during 1987–1990 compared with 1992–2000 (Figure 8). The temporal pattern for average abundance of total fish eggs is less clear: average abundance was low in 1987, 1988, and 1990, moderately high in 1998–2000, high in 1989 and distinctly highest in 1992 (Figure 8). The average volume of water filtered on each survey cruise may be a factor affecting egg and larval abundance, since average volumes of water filtered by Manta net tows were slightly higher during 1992–2000 compared with earlier surveys (Figure 8).

POLYDACTYLUS Group

Polydactylus approximans

Blue bobo, an epibenthic species typically found over soft substrates along beaches and mouths of bays, has pelagic larvae that often occur in high abundance. Relatively high larval concentrations were found off central Mexico in 1999, in the Costa Rica Dome-northern Central America region in 1989, 1990,1992, and 1999, and off the Gulf of Panama in1987, 1992, and 1998 (Figure 9). Average occurrence was higher during 1992–2000 compared with earlier years but average abundance was comparatively high only in 1992 and 1999 (Figure 10).

Prognichthys spp.

Prognichthys is represented in the ETP by two species, the coastal species *P. tringa* and an oceanic species *P. sealei*. The species cannot be distinguished until well into the juvenile period. Inshore concentrations of *Prognichthys* larvae are mostly *P. tringa* whereas oceanic records are likely *P. sealei* (Figure 11). High concentrations occurred along the northern Central American coast northwest of the Costa Rica Dome and in the Cabo Corrientes and Gulf of California region of Mexico. Average occurrence and abundance were lower in the 1987–1990 period compared with later surveys (Figure 10) and a trend of increasing abundance is apparent since, at least, 1998.

Gerreidae

This shorefish family, the mojarras, is represented in the ETP by four genera and about a dozen species. Larvae of the various species are similar, have not been identified below the genus level, and were lumped to family in this study. Small concentrations occurred sporadically along the ETP coastal regions, most consistently along the northern coast of Central America (Figure 12). Average abundance was higher during 1992–2000 compared with earlier survey years (Figure 10).

Mugil spp.

Mugil, the most common genus of the mullet family Mugilidae, is represented by four species in the ETP. Of these, *M. cephalus* and *M. curema* are the most common; however, most of the larvae captured in the Manta nets are small and not separable to species. A few areas of moderately high concentration were off southern Mexico and northern Central America (Figure 13). Abundance was higher during 1998–2000 compared with earlier surveys and occurrence was distinctly lower during 1987–1989 compared to 1990–2000 (Figure14).

Caranx caballus

The green jack is a ubiquitous carangid occurring in coastal waters of southern Baja California and the ETP. Areas of relatively high concentration were along the coasts of Mexico and northern Central America (Figure15). Occurrence and abundance were distinctly higher during 1992–2000 compared to earlier survey years (Figure 14).

Auxis spp.

Two species of bullet tuna occur in the ETP, however their larvae cannot be distinguished. High larval concentrations were in the north equatorial current region or off the Mexican coast (Figure 16). Average larval occurrence was higher in 1992–2000 compared with earlier survey years with perhaps a gradual trend of increasing abundance (Figure 14). Distinctly high abundance for 2000 corresponded to very high catches south of the Gulf of California in that year.

OXYPORHAMPHUS Group

Vinciguerria lucetia

This tropical-subtropical phosichthyid undoubtedly has the largest biomass of any midwater species in the ETP and may have the largest biomass of any vertebrate. It migrates from the mesopelagic to surface waters at night and is an important consumer of secondary production and a major forage species for piscivorous fishes in the ETP. Areas of high larvae concentration, exceeding 80 larvae per 100 m^3, occurred well offshore in equatorial regions in most survey years (Figure 17). The 1999 survey was unusual because clusters of high abundance were somewhat closer to shore than in other surveys; however, there was no trend in average inter-annual occurrence or abundance for the eight surveys (Figure 18).

Oxyporhamphus micropterus

Shortwing flyingfish, a circumtropical species, is abundant throughout the ETP. Highest larval concentrations occurred during1988 and 1989 west of the Costa Rica Dome (Figure 19). There was no trend in average occurrence or abundance; however, both occurrence and abundance were highest in 1992 (Figure 18).

Cubiceps pauciradiatus

This epipelagic species is circumglobal in tropical/subtropical waters and is abundant and widespread in the ETP. Relatively high larval concentrations occurred offshore in the north equatorial current region; however, coastal concentrations occurred off southern Mexico in 1987 and 1998, and off Panama in 1999 and 2000 (Figure 20). There was no trend in average annual occurrence and abundance; however, values were highest in 1992 (Figure 21).

Coryphaena equiselis

Pompano dolphin is circumglobal in warm seas and common offshore in the ETP. Highest larval concentrations were in the Costa Rica Dome area (1998) or to the northwest of it in the north equatorial current region (1987, 1988, 1990) (Figure 22). There was no trend in average annual occurrence and abundance; however, values were highest in 1992 (Figure 21).

ASSOCIATE TAXA

The several species of thread herrings are commercially important schooling fishes in nearshore waters and bays throughout the ETP. *Opisthonema* spp. forms a recurrent group with the grunts (family Haemulidae) and the croakers (family Sciaenidae) but is closely associated with the POLYDACTYLUS recurrent group, sharing critical affinity indices with five of the six members of that group (Table 4). Highest larval concentrations (> 100/100 m^3) were encountered in 1987, 1990, 1998, and 1999 northwest of the Costa Rica Dome, in the Gulf of Tahuantepec region and to the south of it off the coast of Guatemala (Figure 23). In 1999 high concentrations were found in the Gulf of California. Average occurrence and abundance were relatively high in 1987, close to zero in 1988 and 1989, and increased gradually to peak values in 1999 (Figure 24).

Common dolphinfish, *Coryphaena hippurus,* circumglobal in warm seas, is more coastal in distribution than pompano dolphinfish as reflected in larval distributions (Figure 25). It was closely linked with both the coastal and offshore groups, having critical affinity indices with five of the six members in POLYDACTYLUS and two of the four members in OXYPORHAMPHUS (Table 4). Average larval occurrence and abundance were higher in 1992–2000 compared with earlier survey years and 1992 and 2000 were markedly highest (Figure 24). There appeared to be a trend of gradually increasing abundance.

The flyingfish species *Cheilopogon xenopterus* and *Hirundichthys marginatus* are widely distributed in the ETP. Larvae of *C. xenopterus* were linked to *Prognichthys* spp. and *Auxis* spp. in the POLYDACTYLUS group and to two members of the OXYPORHAMPHUS group (Table 4). Larvae of *H. marginatus* were linked to *O. micropterus* and *C. equiselis* in the OXYPORHAMPHUS group. Highest larval concentrations of *C. xenopterus* were found northwest of the Costa Rica Dome from the coast seaward into the north equatorial current region (Figure 26). No trend was apparent in average occurrence or abundance; however values were distinctly higher for 1992 and 2000 (Figure 27). Larvae of *H. marginatus* had similar distributions except high concentrations were found in the Costa Rica Dome area in 1989 and 1990 (Figure 28). Average larval abundance was markedly higher in 1988–1992 compared with 1987 and 1998–2000 (Figure 27).

Larvae of yellowfin and bigeye tuna cannot be reliably distinguished and were grouped to genus in this study. The taxon was linked to *Auxis* spp. in POLYDACTYLUS and to *O.*

marginatus in OXYPORHAMPHUS (Table 4). Larval concentrations of *Thunnus* spp. generally were offshore during 1987–90 and more coastal in later survey years (Figure 29). Average occurrence and abundance were highest in 1992 and 1998 compared to previous and later survey years (Figure 30). The genus *Euthynnus* is represented in the ETP by *E. lineatus*, a common and wide-ranging species of both coastal and oceanic waters. Larvae were associated with *P. approximans* in the POLYDACTYLUS group (Table 4). Centers of larval concentration were found in the Costa Rica Dome area in 1989,1992, and 1998 (Figure 31). Average annual occurrence and abundance were highest in 1992 and 1998 (Figure 30). The myctophid *Benthosema panamense* is a midwater species of high productivity coastal regions of the ETP that migrates to surface waters at night and can occur in large aggregations. Tuna, marine mammals, and birds are known to feed extensively on these aggregations. It forms a recurrent group with a sanddab species *Citharichthys platophrys* and the goby family Gobiidae (Table 4). Larval concentrations were found coastally in the region northwest of the Costa Rica Dome in 1987, 1990, and 1992 and off Costa Rica in 1999 (Figure 32). Average occurrence was higher in 1992–2000 compared with earlier years but this pattern was not apparent for average abundance (Figure 30).

DISCUSSION

Recurrent group analysis of surface samples from eight surveys in the ETP (1987–2000) identified two major groups. The POLYDACTYLUS group was made up of primarily coastal taxa whereas the OXYPORHAMPHUS group consisted of offshore or oceanic taxa. The two groups were phylogenetically diverse with a relatively high number of between-group affinities. The two three-member groups (OPISTHONEMA and BENTHOSEMA) and one of the two-member groups (BOTHUS) were primarily coastal in distribution whereas the remaining two-member groups (CERATOSCOPELUS, TRIPHOTURUS, and NEALOTUS) consisted of offshore taxa. In recurrent group analysis the object of the REGROUP program is to assemble the most and largest groups possible with the result that commonly occurring taxa with large numbers of associations will devolve to form smaller groups, leaving the larger groups to be formed by highly associated taxa with relatively fewer alternatives. In some cases important common taxa may not be included in one of the large recurrent groups or may not be included in a group at all. For example, in the POLYDACTYLUS group note that *Coryphaena hippurus* had significant affinities with all but one member (*Caranx caballus*) but was not included as a member. Also, note that although *Opisthonema* spp. was linked to all but one POLYDACTYLUS member (*Polydactylus approximans*) it was included instead in a three-member group with two families of shorefish (Haemulidae and Sciaenidae). Thus, when selecting indicator taxa for ecological analysis it is important to consider the associates of large recurrent groups and members of smaller groups that have strong interconnections with members of the large recurrent groups.

The oceanic ETP, with its high productivity and shallow oxygen minimum layer, is inhabited by a distinct fauna consisting of pan-tropical and endemic species (Brinton 1962) while the entire nearshore habitat is included in the Panamic zoogeographic province. Thus, it is not surprising that the two principal assemblages identified were shorefish vs oceanic and that zonal oceanic or shorefish groups did not emerge from the analysis. Examination of variation in occurrence and abundance of key larval taxa identified by the recurrent group analysis revealed no consistent interannual trends in spatial distribution of larval concentrations. Highest concentrations of coastal taxa usually were in upwelling regions along the Mexican and northern Central American coast and highest concentrations of oceanic taxa were offshore of this region, usually to the northwest of the highly productive Costa Rica Dome. Presumably, the high larval productivity in the region is derived from nutrients advected to the region by the North Equatorial Current. Generally, occurrence and abundance of key shorefish taxa were higher in surveys conducted from 1992 to 2000 compared with the MOPS surveys of 1987–1990; however, this is may be associated with the relatively higher nearshore sampling effort during 1992–2000. Offshore taxa exhibited no inter-annual trend or dichotomy in abundance between earlier and later surveys although larval abundance during 1992 was consistently high for most offshore taxa. The reason for that is not clear since sampling in 1992 was mostly restricted to region 3, and therefore heavily weighted to an inshore region of the ETP. This region includes the Costa Rica Dome and is characterized by nutrient levels typically higher than other regions of the ETP and may support higher larval fish production of both nearshore and oceanic taxa. The higher average volumes of water filtered during 1992–2000 (Figure 8) could have resulted in an increased number of taxa per tow but should not produce higher average numbers of larvae per unit volume.

This preliminary analysis of ichthyoplankton catches from ETP Manta net tows taken during the period from 1987 to 2000 did not reveal any obvious inter-annual differences in composition and distribution of larval fish assemblages. Average occurrence and abundance of key coastal taxa were generally higher during surveys in 1992–2000 compared to earlier surveys; however, this may be related to increased nearshore sampling effort during 1992–2000. Future analyses will examine this potential bias. Also, future analyses will include the three years (1998–2000) of oblique tows that were taken in conjunction with the surface tows. Ichthyoplankton data from these will be compared with data from oblique tows taken during the Eastropac surveys to examine potential inter-regime differences. The ichthyoplankton data will be included with other biological and oceanographic data in an ecosystem-scale multivariate analysis of the ETP. This may reveal inter-annual correlations not apparent in our preliminary examination of the Manta net catches.

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LITERATURE CITED

Ambrose, D. A., R. L. Charter, H. G. Moser, and S. B. Reilly. 2000. Ichthyoplankton and station data for surface tows taken during the 1988 eastern tropical Pacific dolphin survey on the research vessels *David Starr Jordan* and *McArthur*. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-288. 40 pp.

Brown, D. M. and L. Cheng. 1981. New net for sampling the ocean surface. Mar. Ecol. Prog. Ser.5:224–227.

Brinton, E. 1962. The distribution of Pacific eusphausiids. Bull. Scripps Inst. Oceanogr. 8:125–189.

Charter, S. R., R. L. Charter, H. G. Moser, and S. B. Reilly. 2000. Ichthyoplankton and station data for surface tows taken during the 1989 eastern tropical Pacific dolphin survey on the research vessels *David Starr Jordan* and *McArthur*. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-289. 45 pp.

Fager, E. W. 1957. Determination and analysis of recurrent groups.Ecology 38:586–595.

Fager, E. W. 1963. Communities of organisms. Pages 415–437. *In* M. N. Hill (ed.). The sea. Vol. II. Interscience. New York, N.Y.

Fischer, W., F. Krupp, W. Schneider, C. Sommer, K. E. Carpenter, and V. H. Niem, eds. 1995. Guia FAO para la identificación de especies para los fines de la pesca. Pacifico Centro-Oriental. FAO Rome. 1813 pp. [in Spanish].

Moser, H. G. (ed.). 1996. The early stages of fishes in the California Current region. CalCOFI Atlas 33. 1505 pp.

Moser, H. G., R. L. Charter, S. B. Reilly, D. A. Ambrose, S. R. Charter, E. M. Sandknop, and W. Watson. 2000. Ichthyoplankton and station data for surface tows taken during the 1987 eastern tropical Pacific dolphin survey on the research vessels *David Starr Jordan* and *McArthur*. U. S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-287. 45 pp.

Moser, H. G., P. E. Smith, and L. E. Eber. 1987. Larval fish assemblages in the California Current region, 1954–1960, a period of dynamic environmental change. Calif. Coop. Ocean. Fish. Invest. Rep. 28:97–127.

Powles, H. and D. F. Markle. 1984. Identification of larvae. Pages 31-33 *in* H. G. Moser, W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall, Jr., and S. L. Richardson, eds. Ontogeny and Systematics of Fishes. Am. Soc. Ichthyol. Herpetol. Spec. Publ. 1. 760 pp.

Sandknop, E. M., R. L. Charter, H. G. Moser, and S. B. Reilly. 2000. Ichthyoplankton and station data for surface tows taken during the 1990 eastern tropical Pacific dolphin survey on the research vessels *David Starr Jordan* and *McArthur*. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-290. 46 pp.

Smith, P. E. and H. G. Moser. 1988. CalCOFI time series: an overview of fishes. Calif. Coop. Ocean. Fish. Invest. Rep. 29:66–77.

Watson, W., R. L. Charter, H. G. Moser, and S. B. Reilly. 2000. Ichthyoplankton and station data for surface tows taken during the 1992 eastern tropical Pacific common dolphin survey on the research vessels *David Starr Jordan* and *McArthur*. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-291. 50 pp.

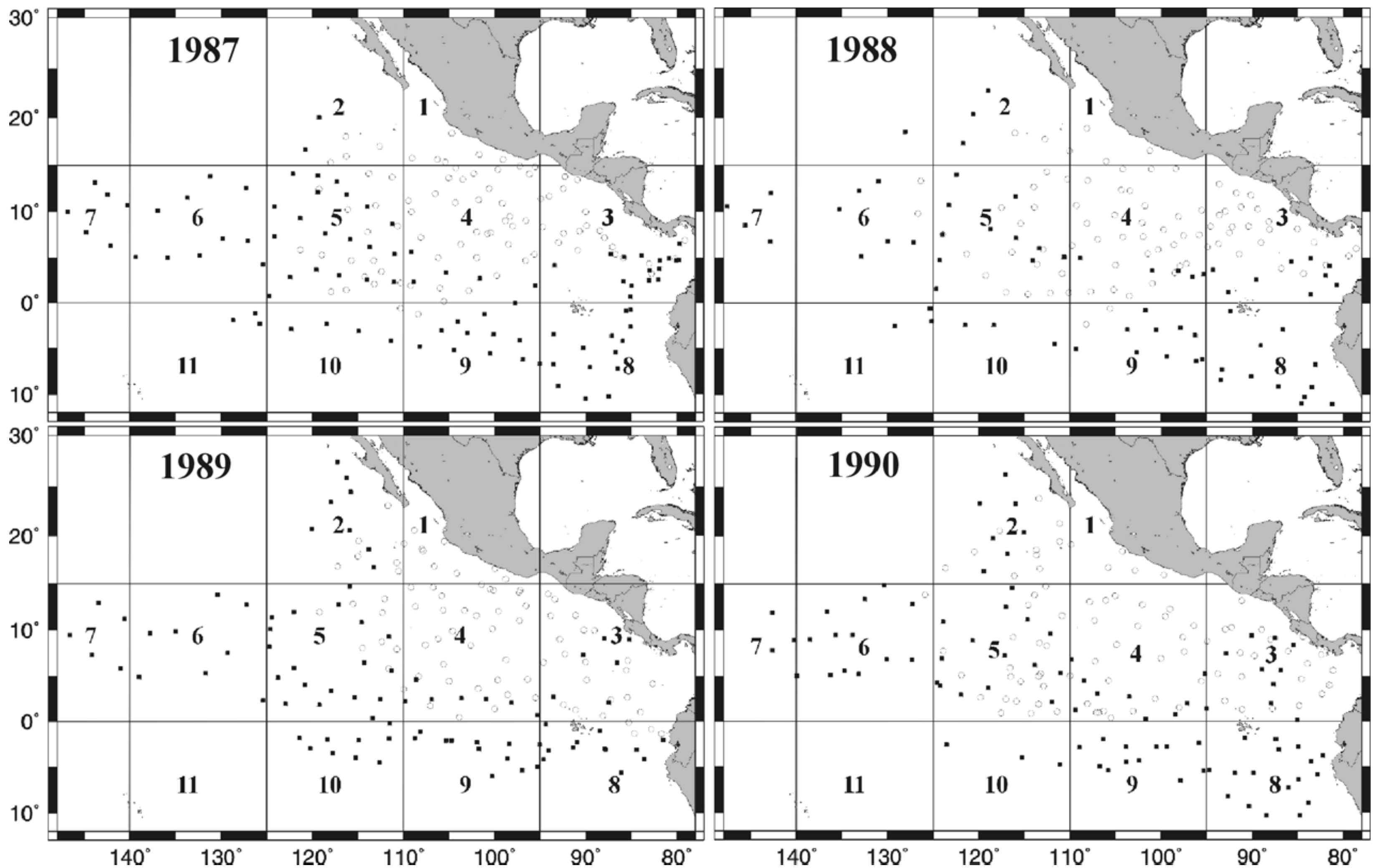

Figure 1. Station map for Manta net tows taken on Marine Mammal Division surveys in 1987, 1988, 1989, and 1990, with regions used in the analysis of ichthyoplankton. Circles = *D. S. Jordan* stations; solid squares = *McArthur* stations.

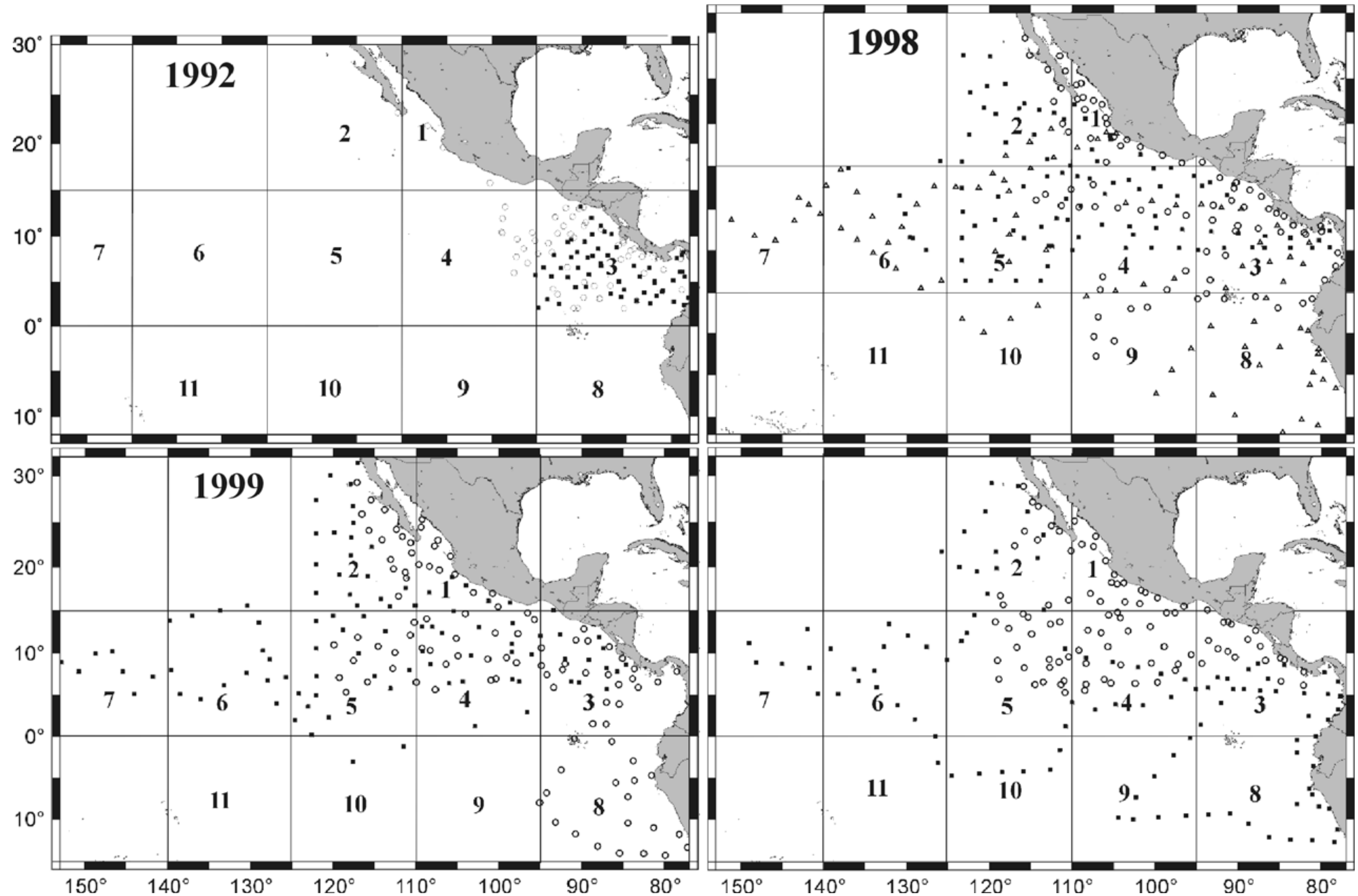

Figure 2. Station map for Manta net tows taken on Marine Mammal Division surveys in 1992, 1998, 1999, and 2000, with regions used in the analysis of icthyoplankton. Circles = *D. S. Jordan* stations; solid squares = *McArthur* stations; Triangles = *Endeavor* stations. *Endeavor* participated in 1998 only.

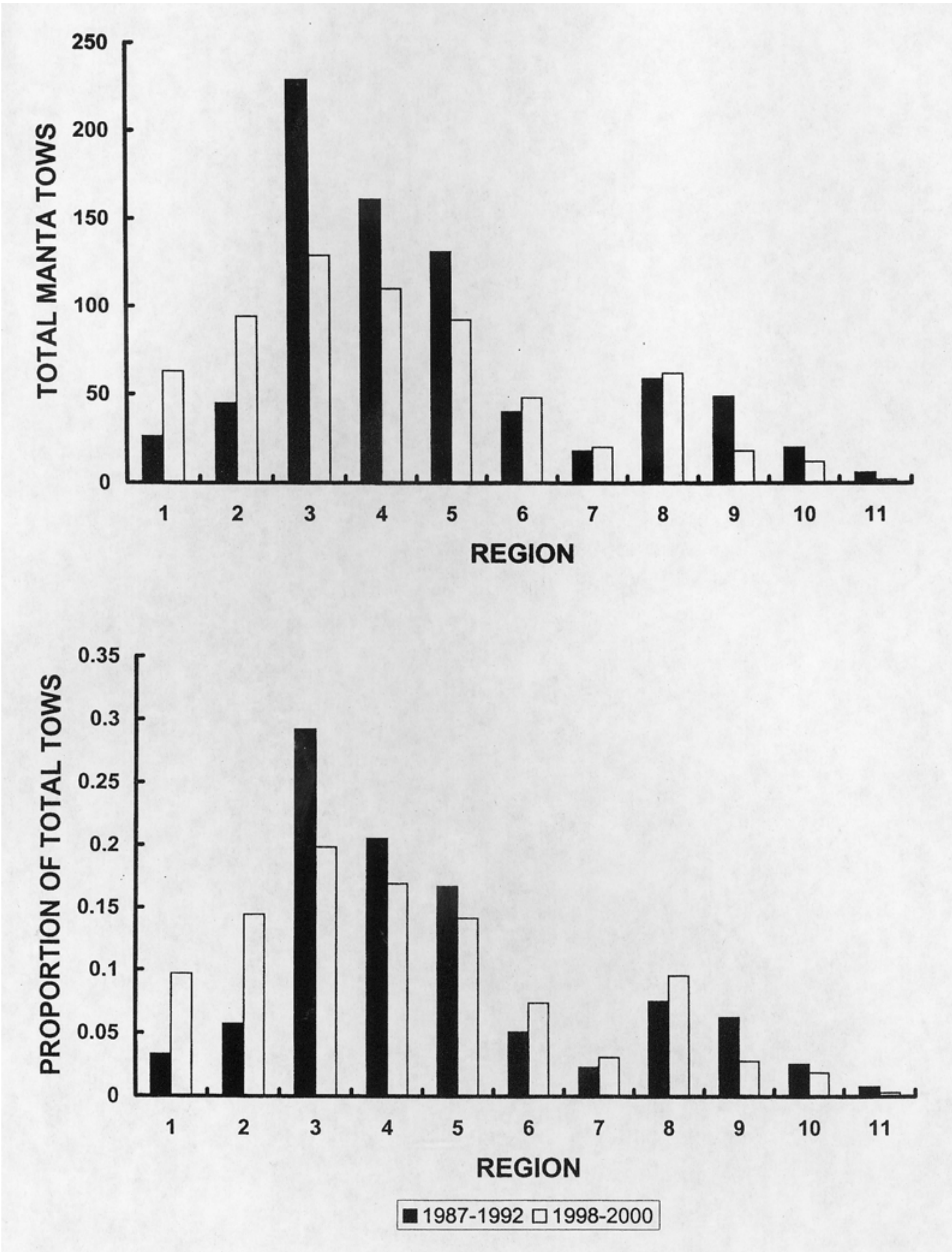

Figure 3. Numbers (above) and proportion of total (below) Manta tows taken in each region on Marine Mammal Division surveys during 1987–1992 and 1998–2000.

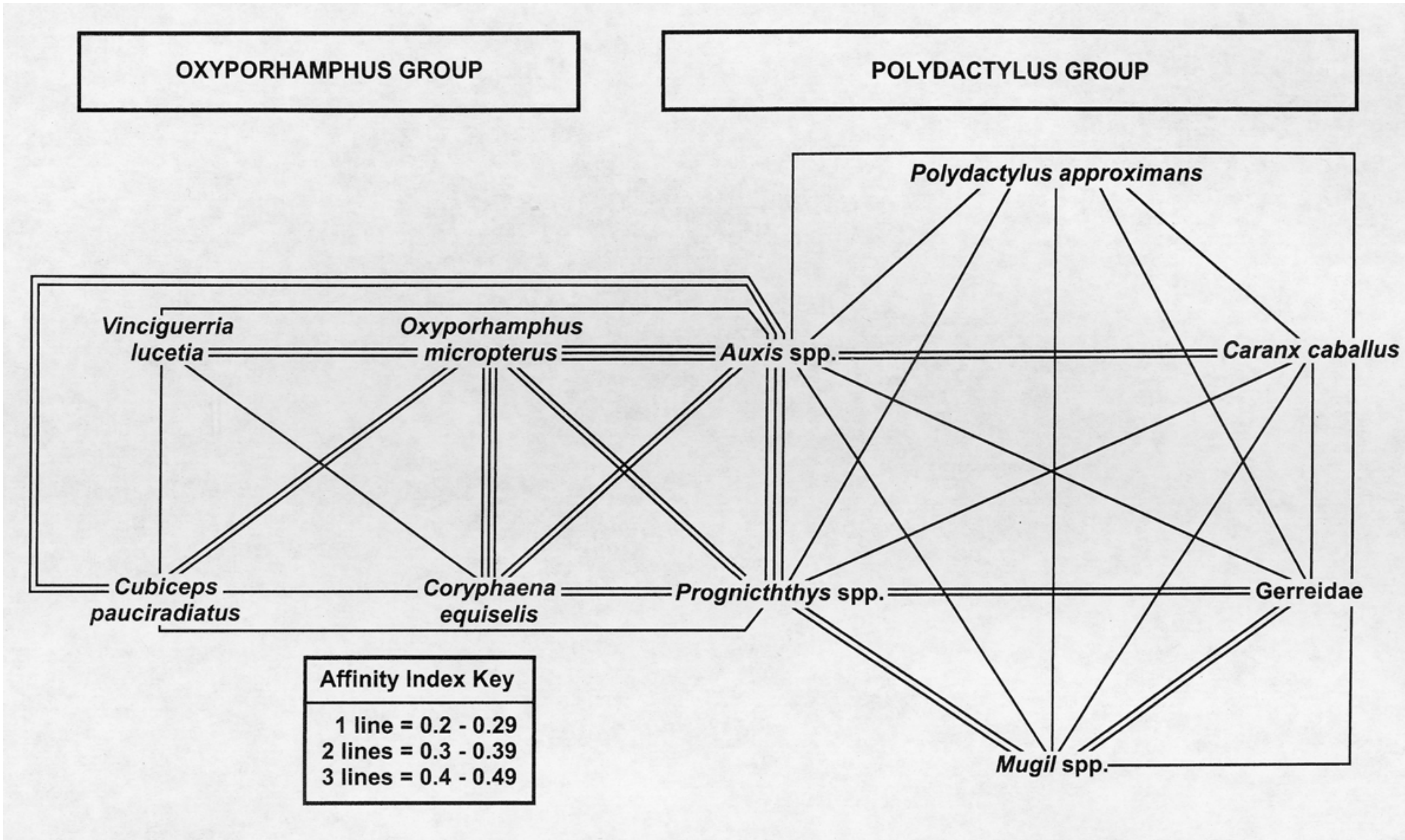

Figure 4. Diagram of two major recurrent groups of fish larvae from Manta net catches in the eastern tropical Pacific during 1987–2000.

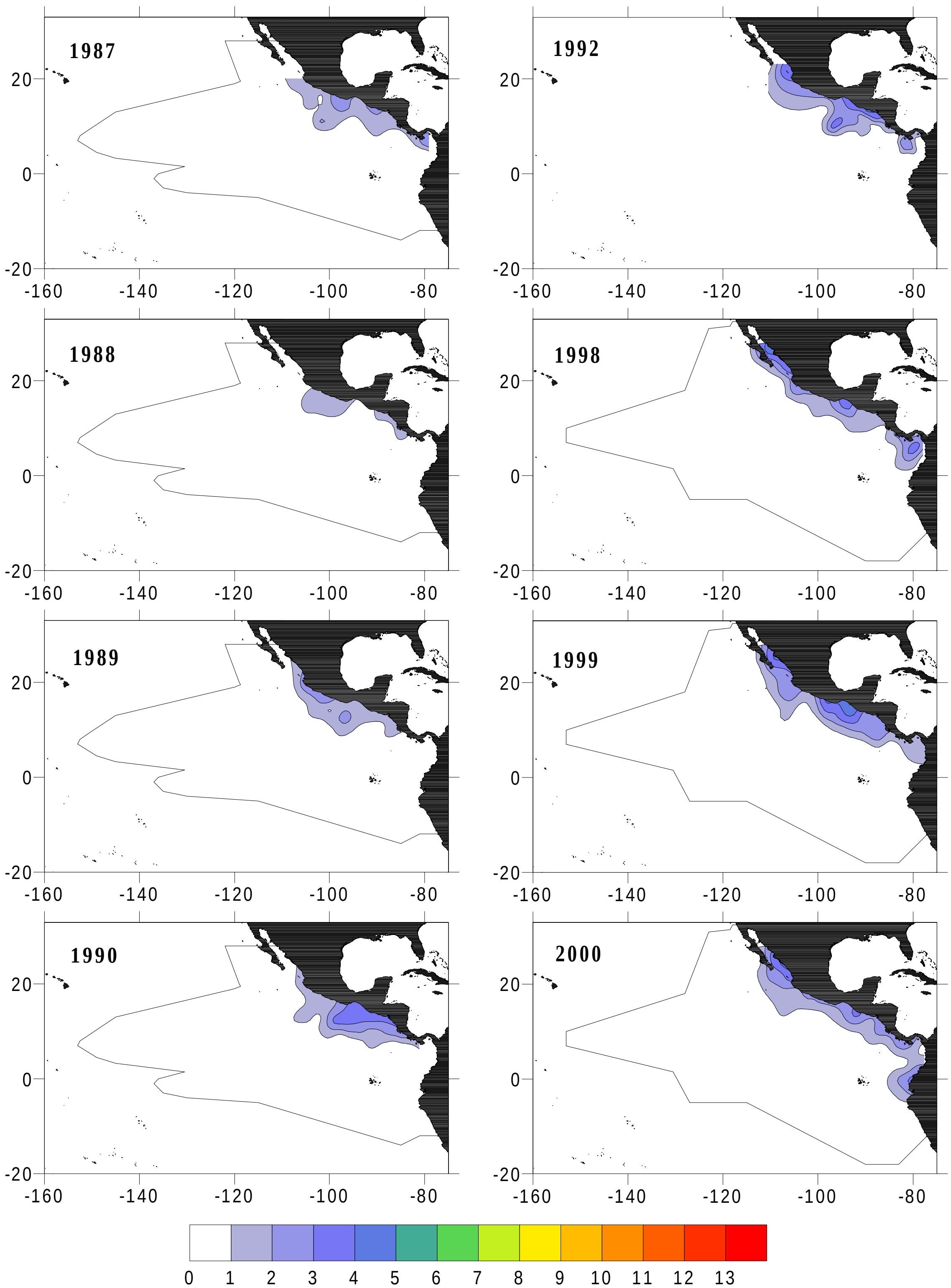

Figure 5. Distributions of the number of group members of POLYDACTYLUS recurrent group at Manta net stations during 1987–2000.

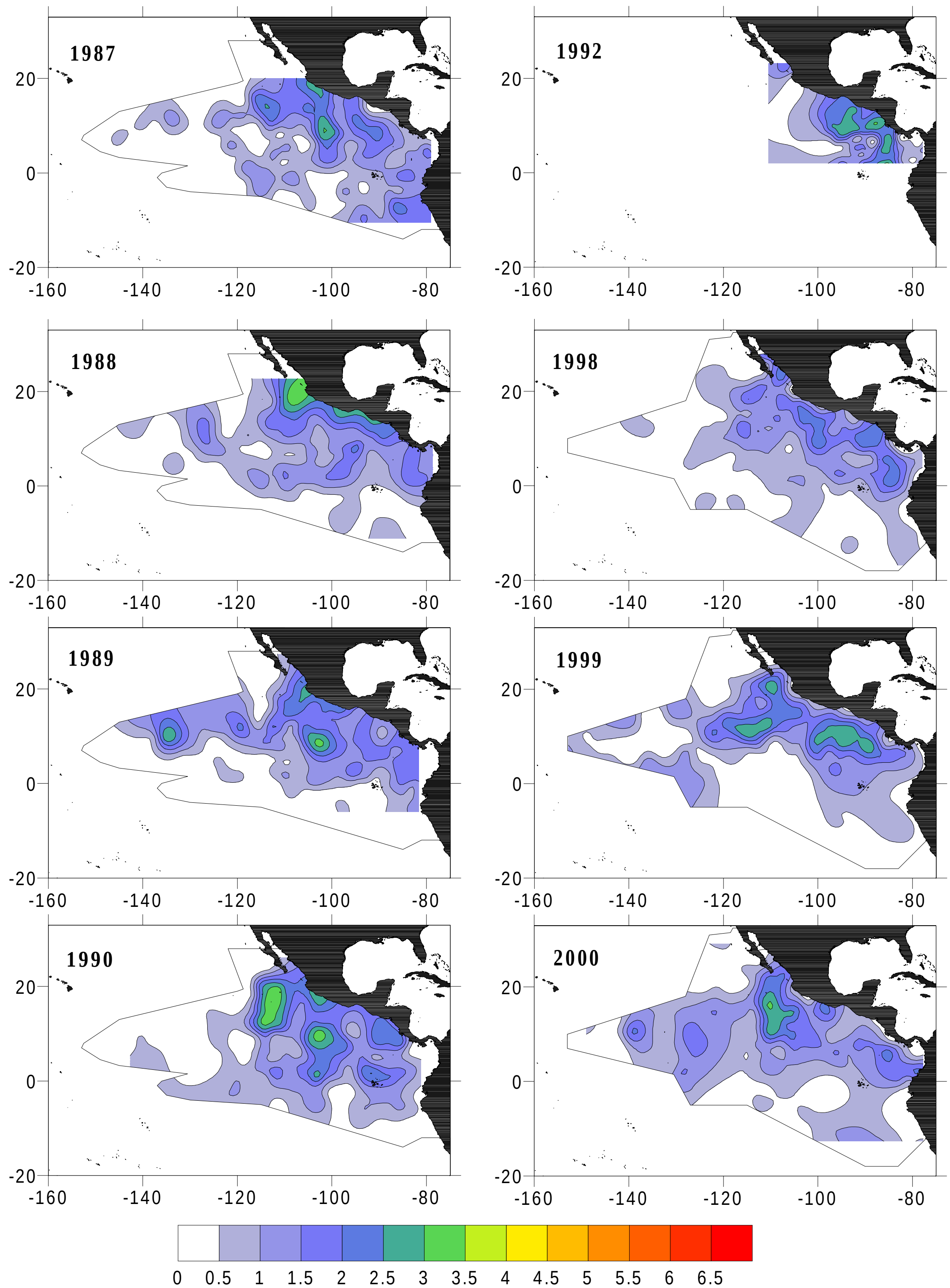

Figure 6. Distributions of the number of group members of OXYPORHAMPHUS recurrent group at Manta net stations during 1987–2000.

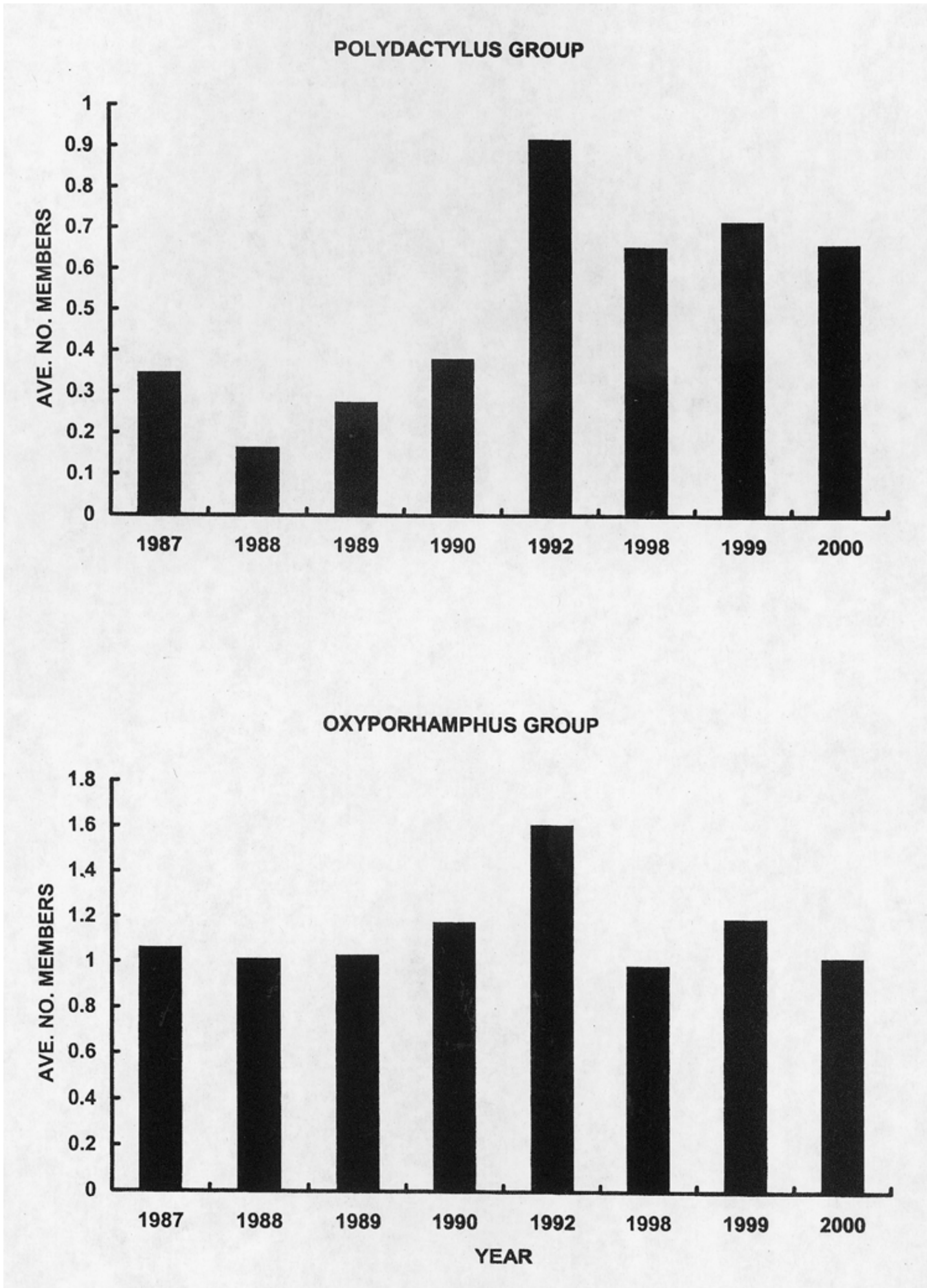

Figure 7. Average number of members in POLYDACTYLUS (above) and OXYPORHAMPHUS (below) recurrent groups during1987–2000.

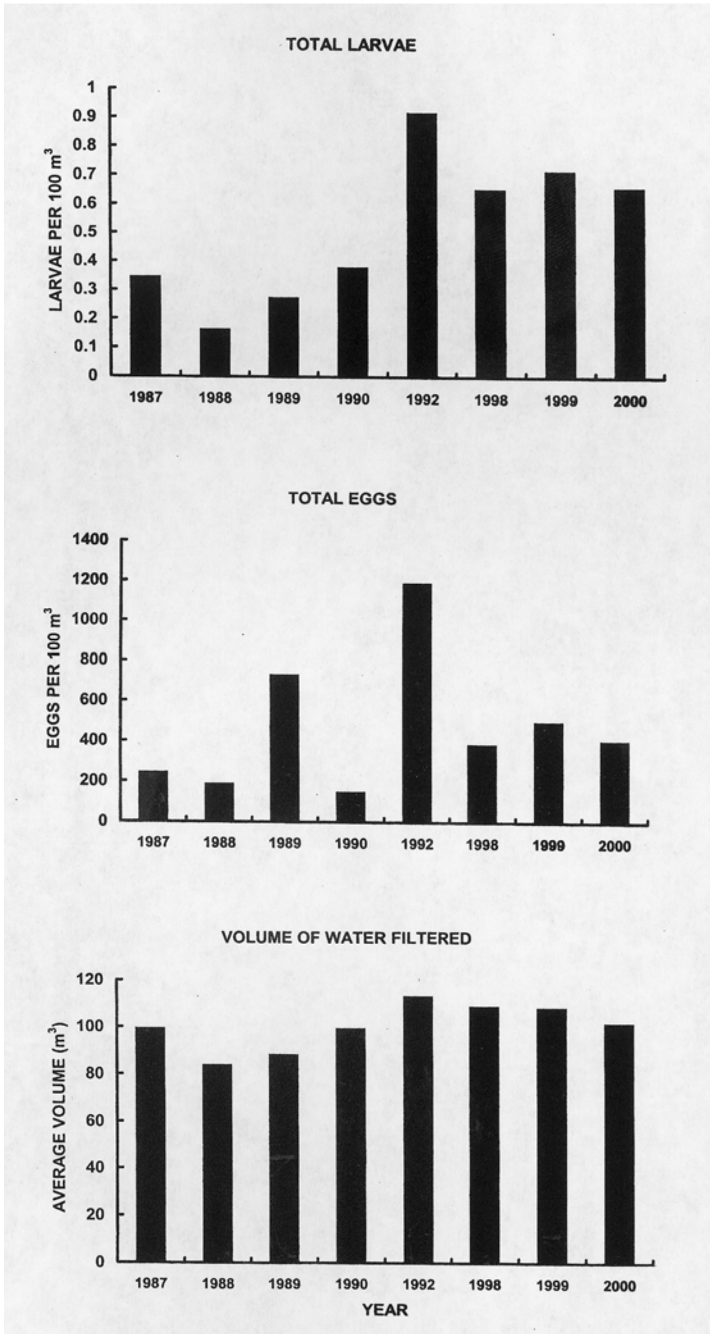

Figure 8. Average concentration of total fish larvae (above), total fish eggs (middle), and volume of water filtered (below) in Manta net tows during 1987–2000.

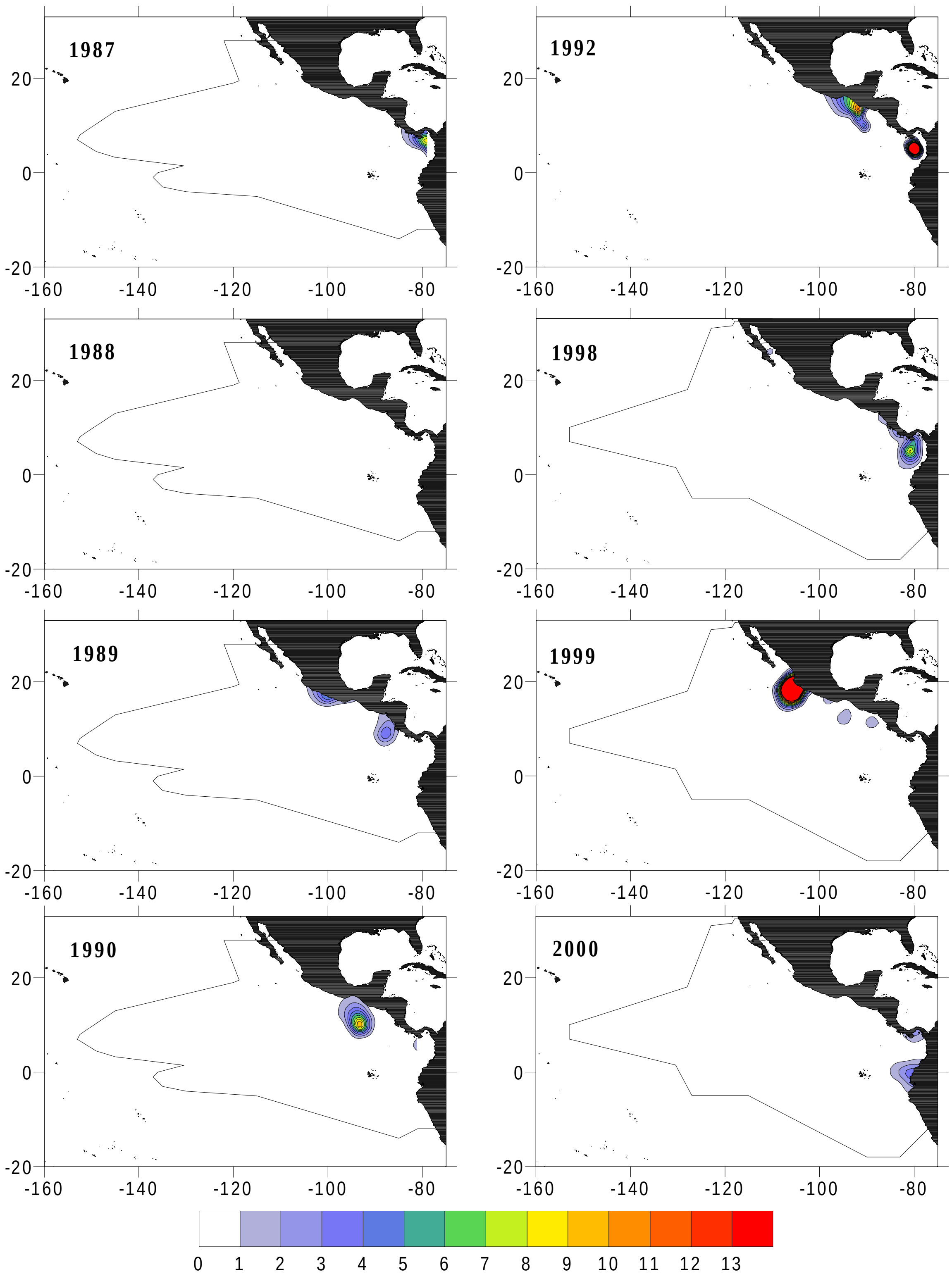

Figure 9. Contour maps of average abundance of *Polydactylus approximans* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 10 larvae/100 m^3 of water filtered.

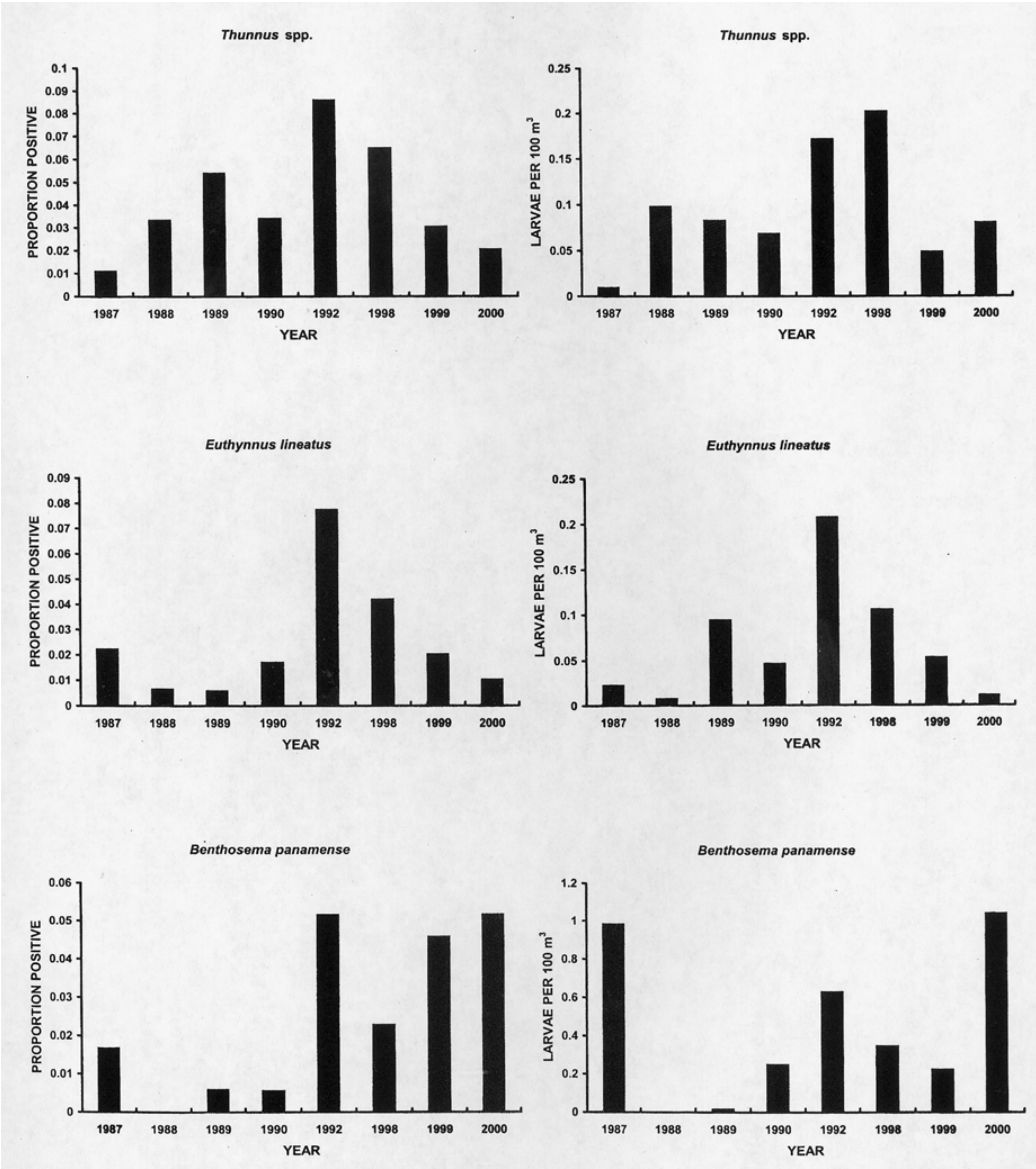

Figure 10. Average occurrence (proportion of positive tows) and abundance (larvae per 100 m^3) of *Polydactylus approximans* (above), *Prognichthys* spp. (middle), and Gerreidae (below) larvae taken in Manta net tows during eight surveys (1987–2000) in the eastern tropical Pacific.

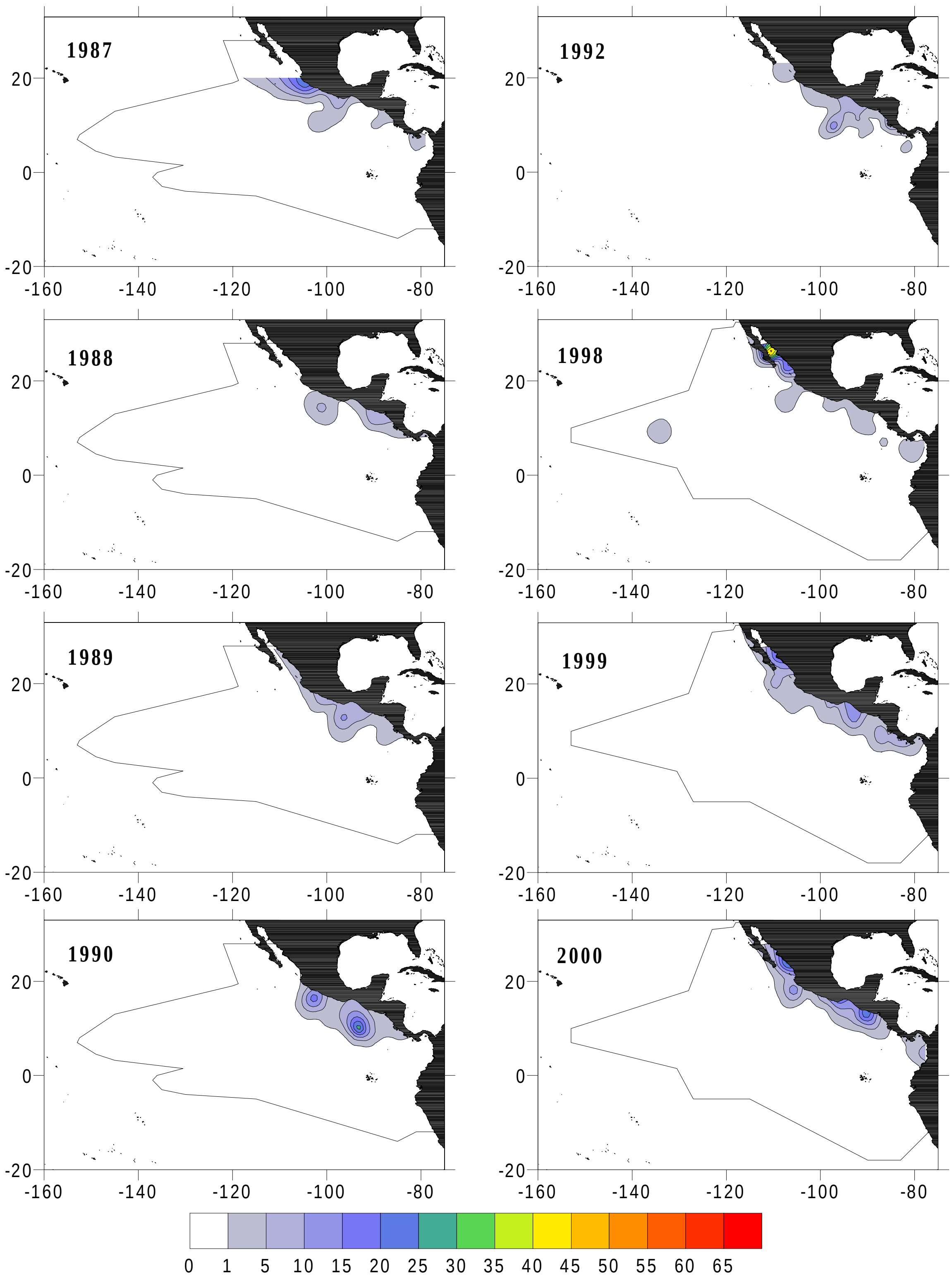

Figure 11. Contour maps of average abundance of *Prognichthy* spp. larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 5 larvae/100 m^3 of water filtered.

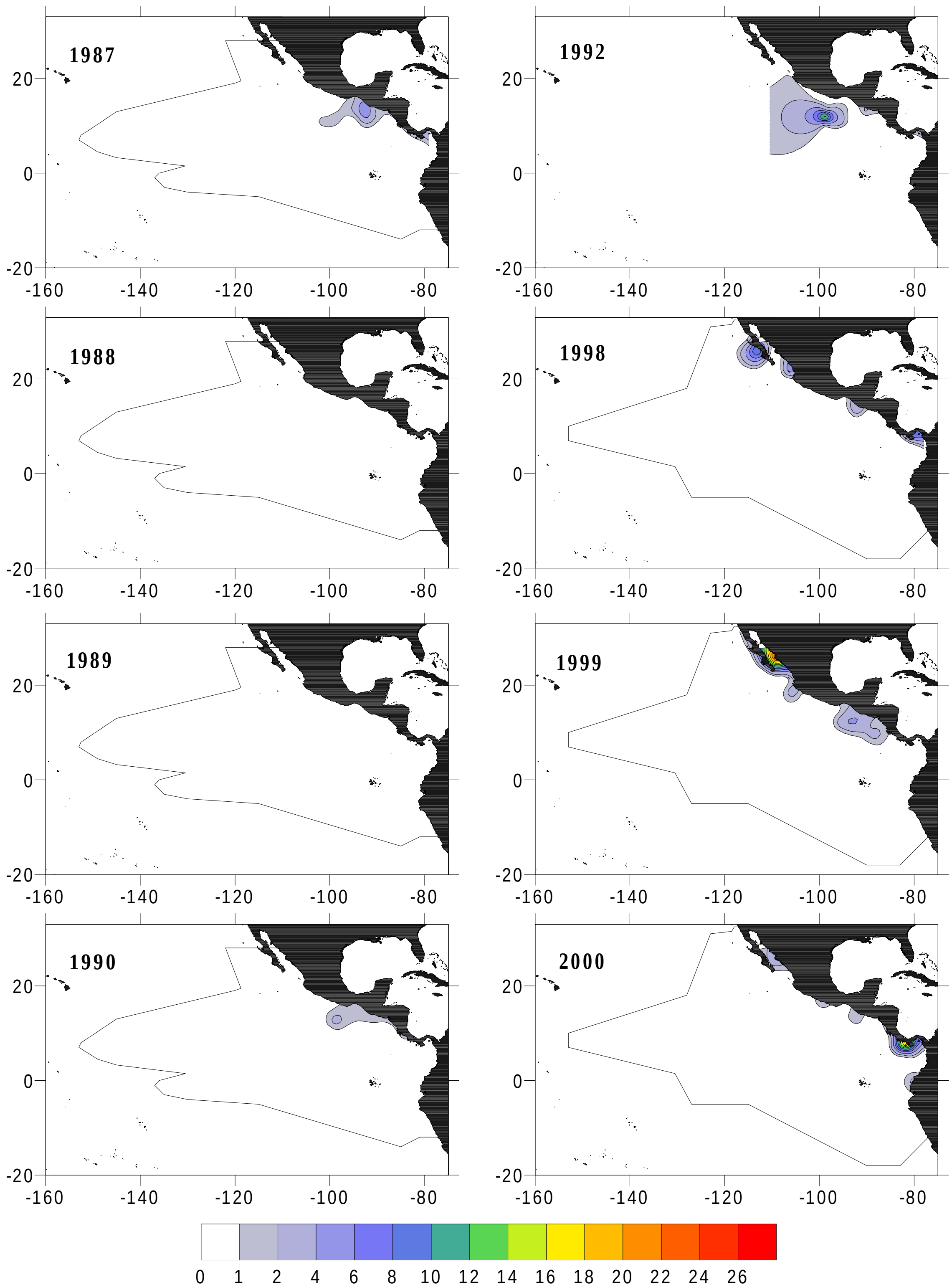

Figure 12. Contour maps of average abundance of Gerreidae larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 2 larvae/100 m^3 of water filtered.

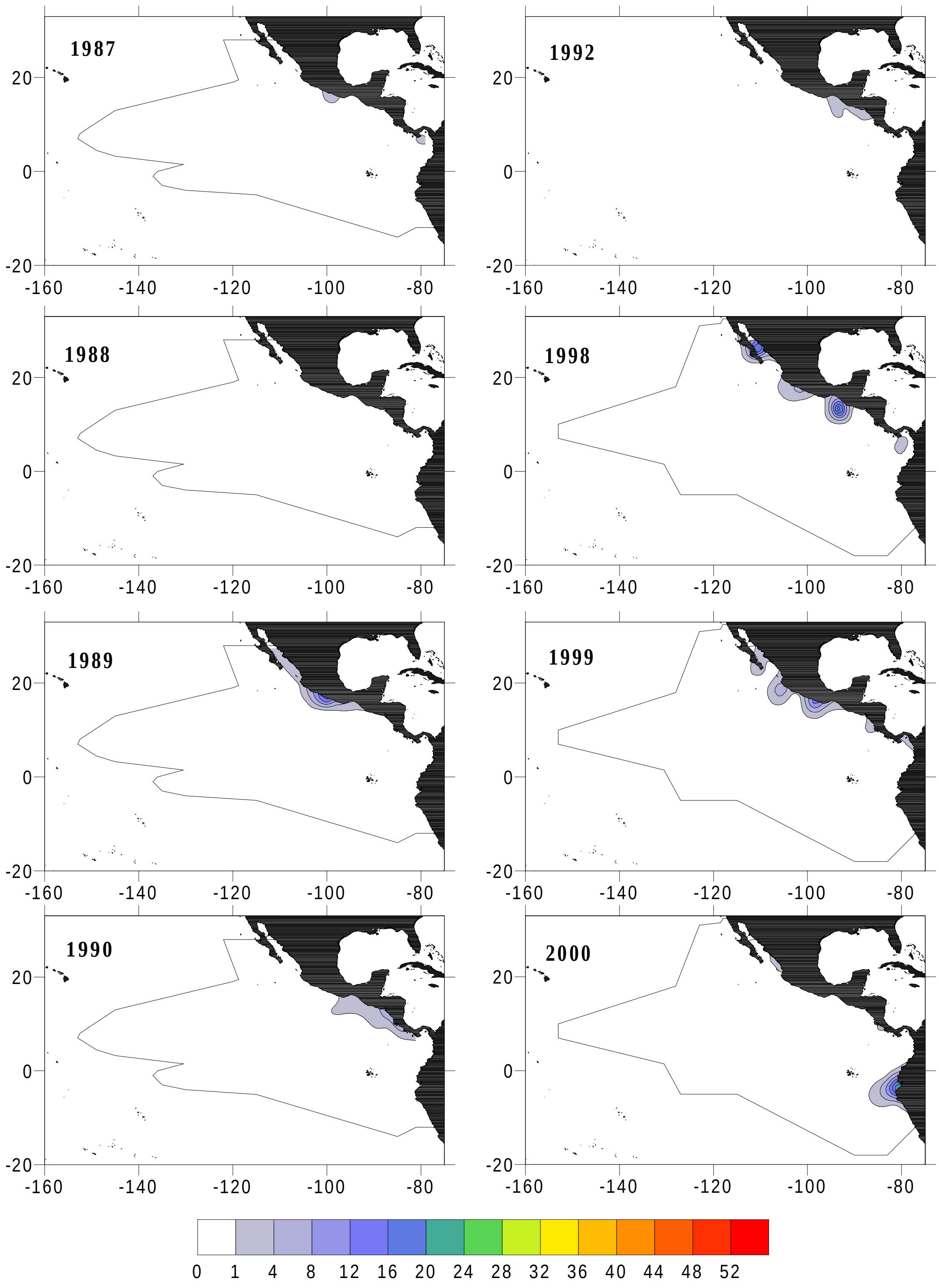

Figure 13. Contour maps of average abundance of *Mugil* spp. larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 4 larvae/100 m^3 of water filtered.

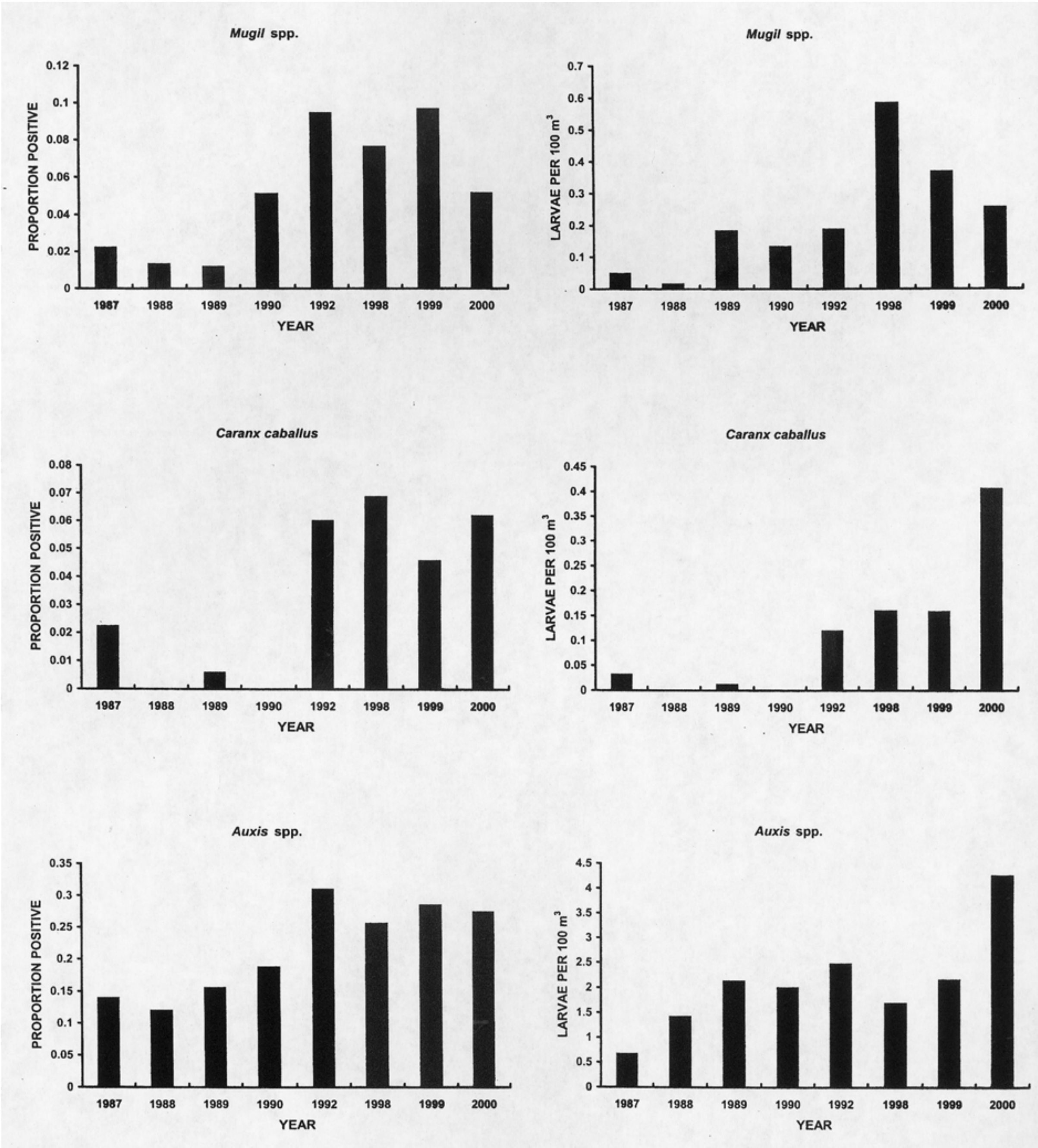

Figure 14. Average occurrence (proportion of positive tows) and abundance (larvae per 100 m^3) of *Mugil* spp. (above), *Caranx caballus* (middle), and *Auxis* spp. (below) larvae taken in Manta net tows during eight surveys (1987–2000) in the eastern tropical Pacific.

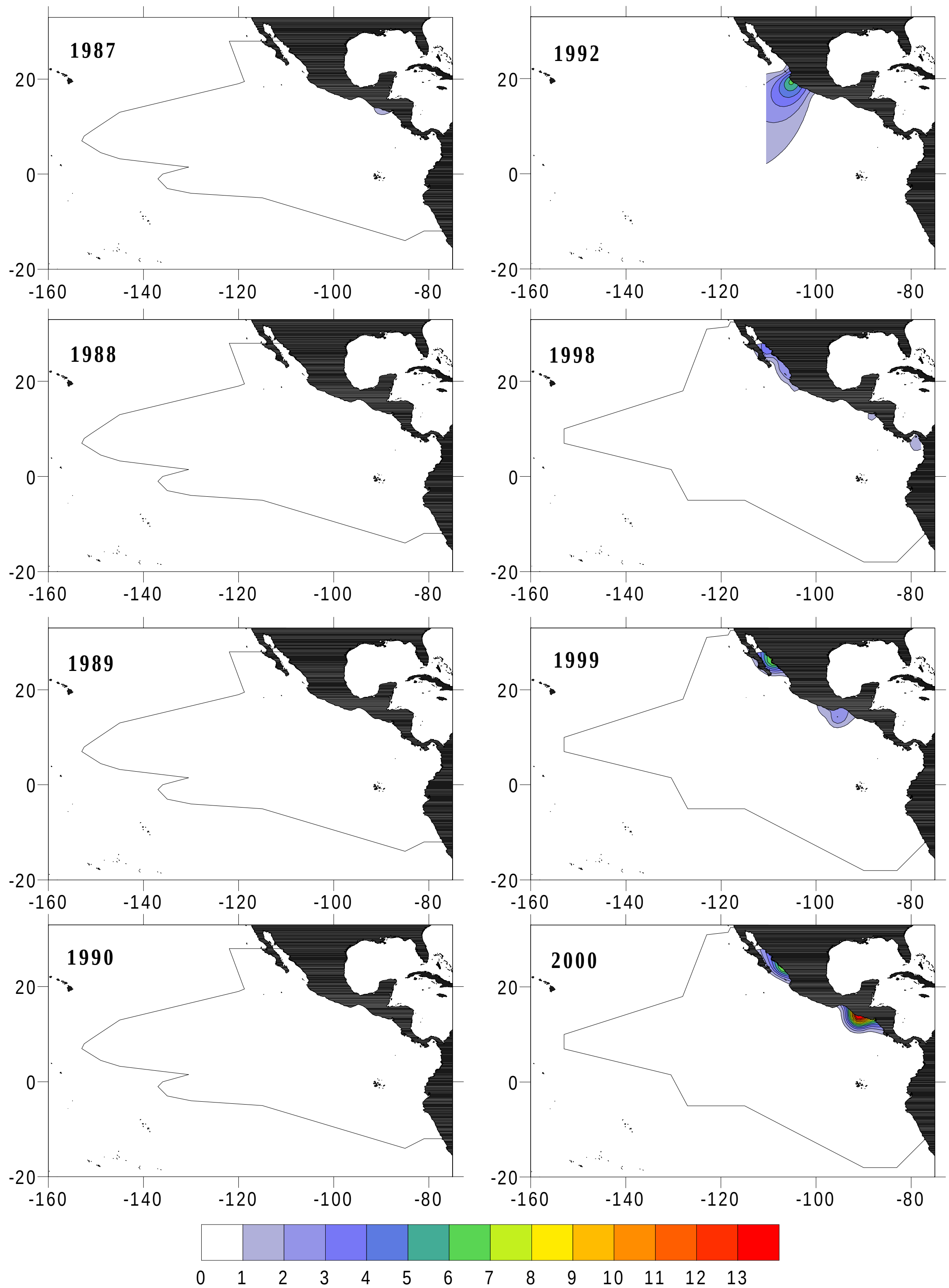

Figure 15. Contour maps of average abundance of *Caranx caballus* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 1 larva/100 m^3 of water filtered.

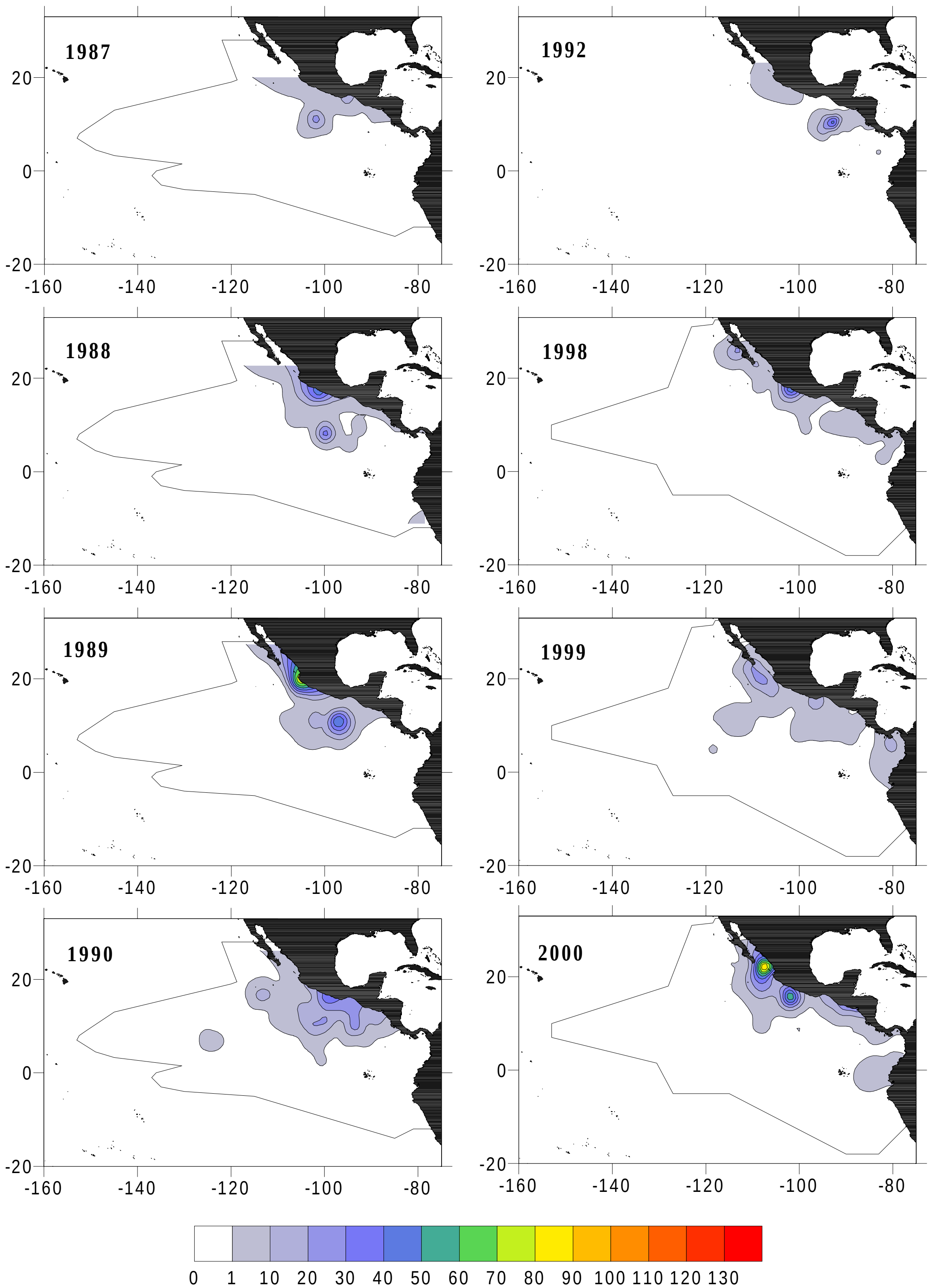

Figure 16. Contour maps of average abundance of *Auxis* spp. larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 10 larvae/100 m^3 of water filtered.

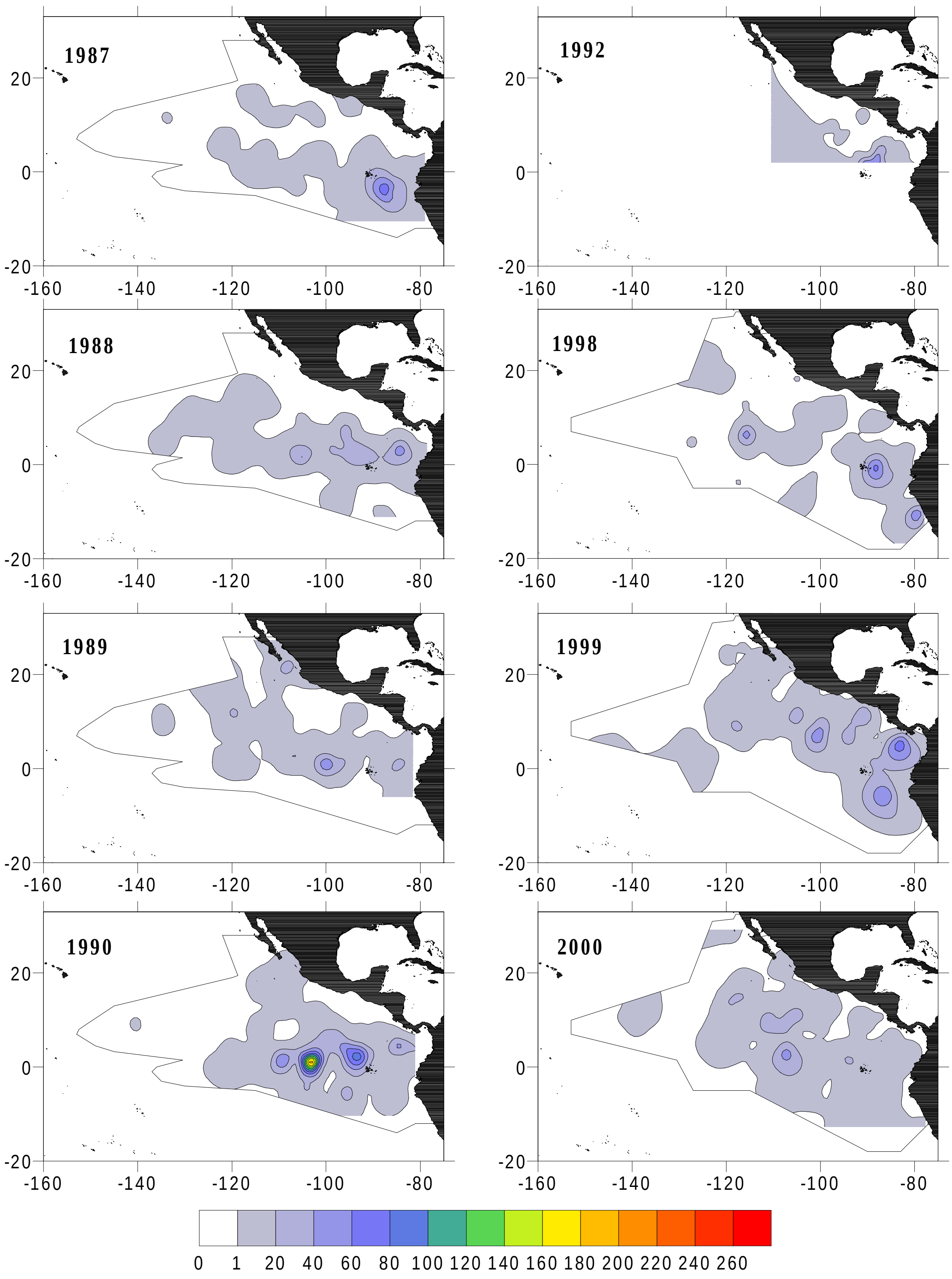

Figure 17. Contour maps of average abundance of *Vinciguerria lucetia* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 20 larvae/100 m^3 of water filtered.

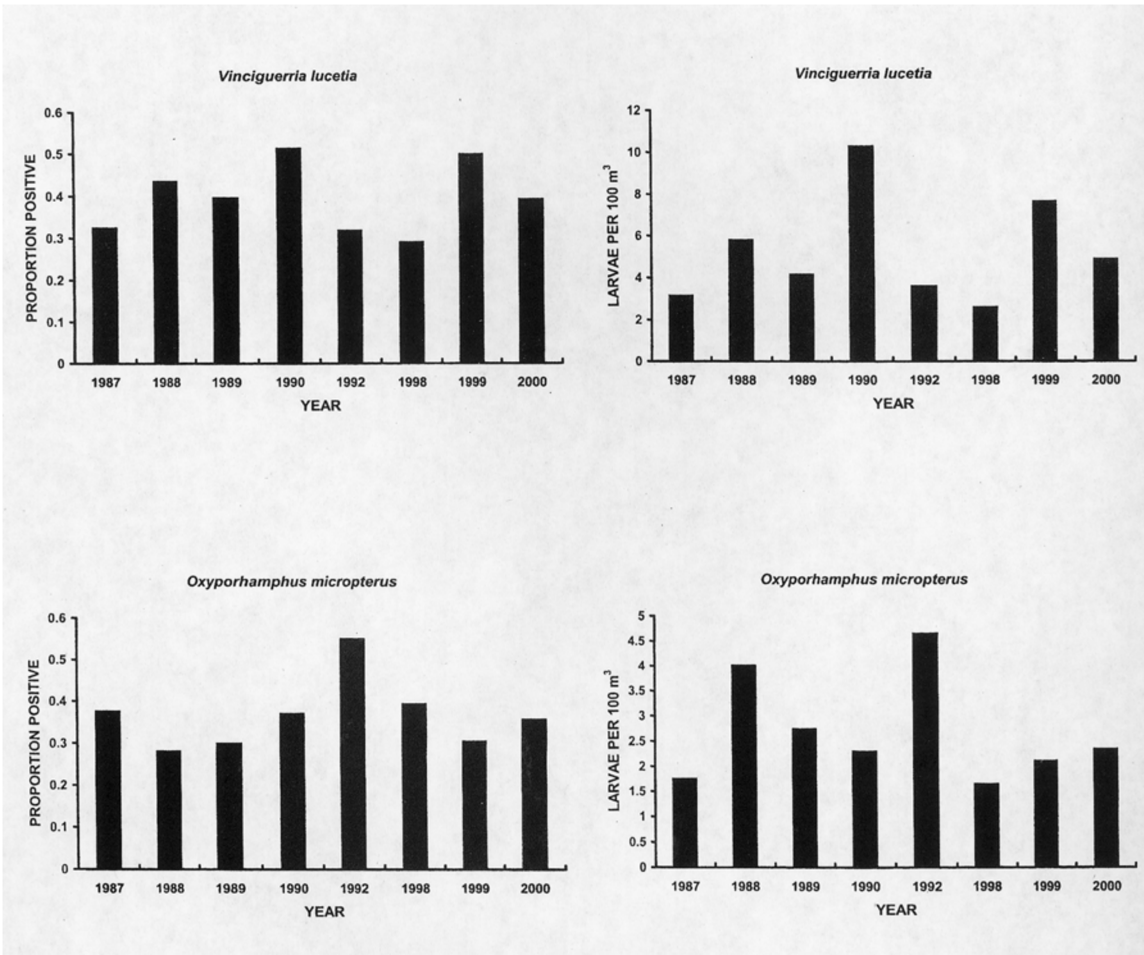

Figure 18. Average occurrence (proportion of positive tows) and abundance (larvae per 100 m^3) of *Vinciguerria lucetia* (above) and *Oxyporhamphus micropterus* (below) larvae taken in Manta net tows during eight surveys (1987–2000) in the eastern tropical Pacific.

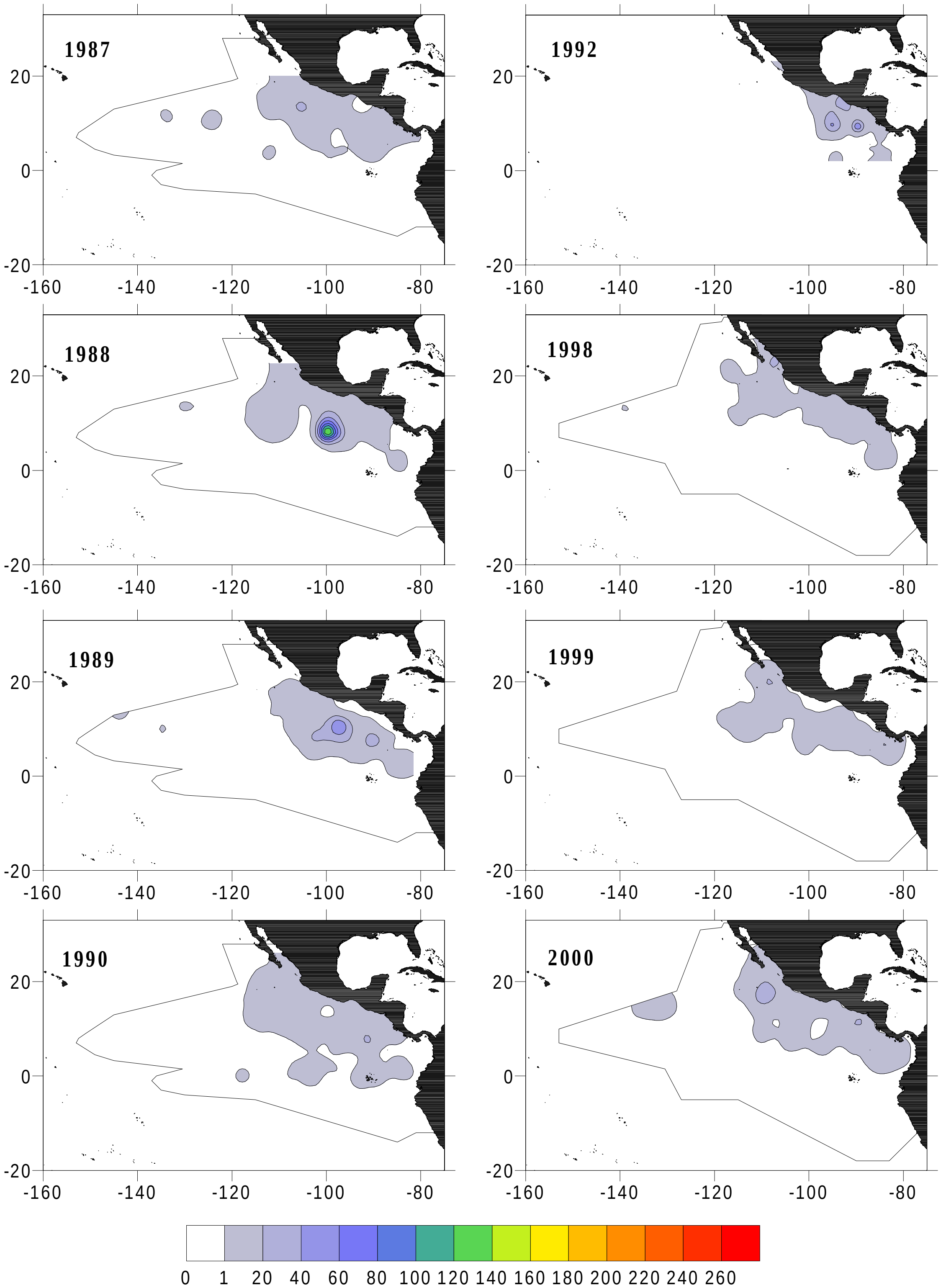

Figure 19. Contour maps of average abundance of *Oxyporhamphus micropterus* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 20 larvae/100 m^3 of water filtered.

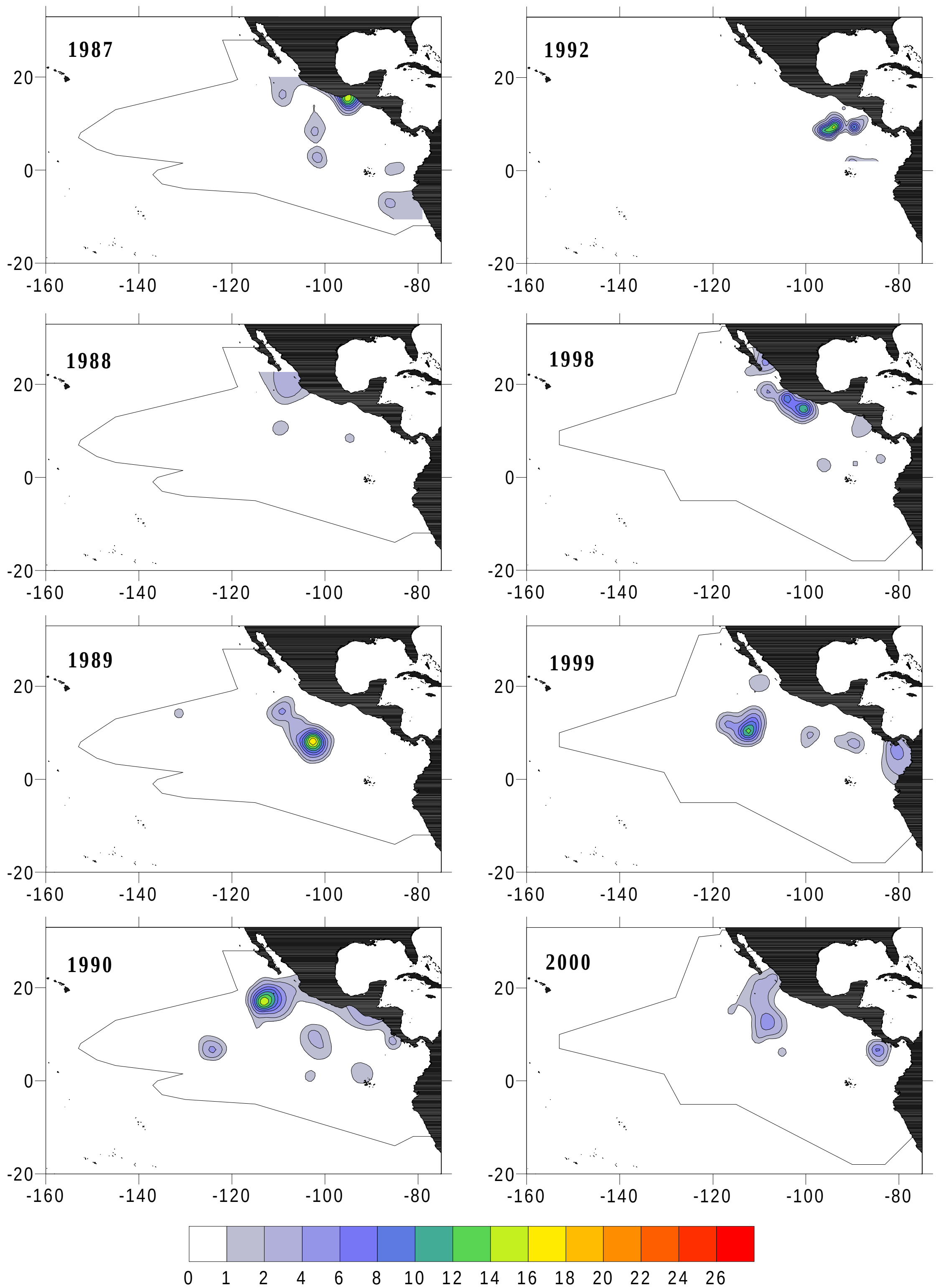

Figure 20. Contour maps of average abundance (larvae/100 m^3 water filtered) of *Cubiceps pauciradiatus* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 2 larvae/100 m^3 of water filtered.

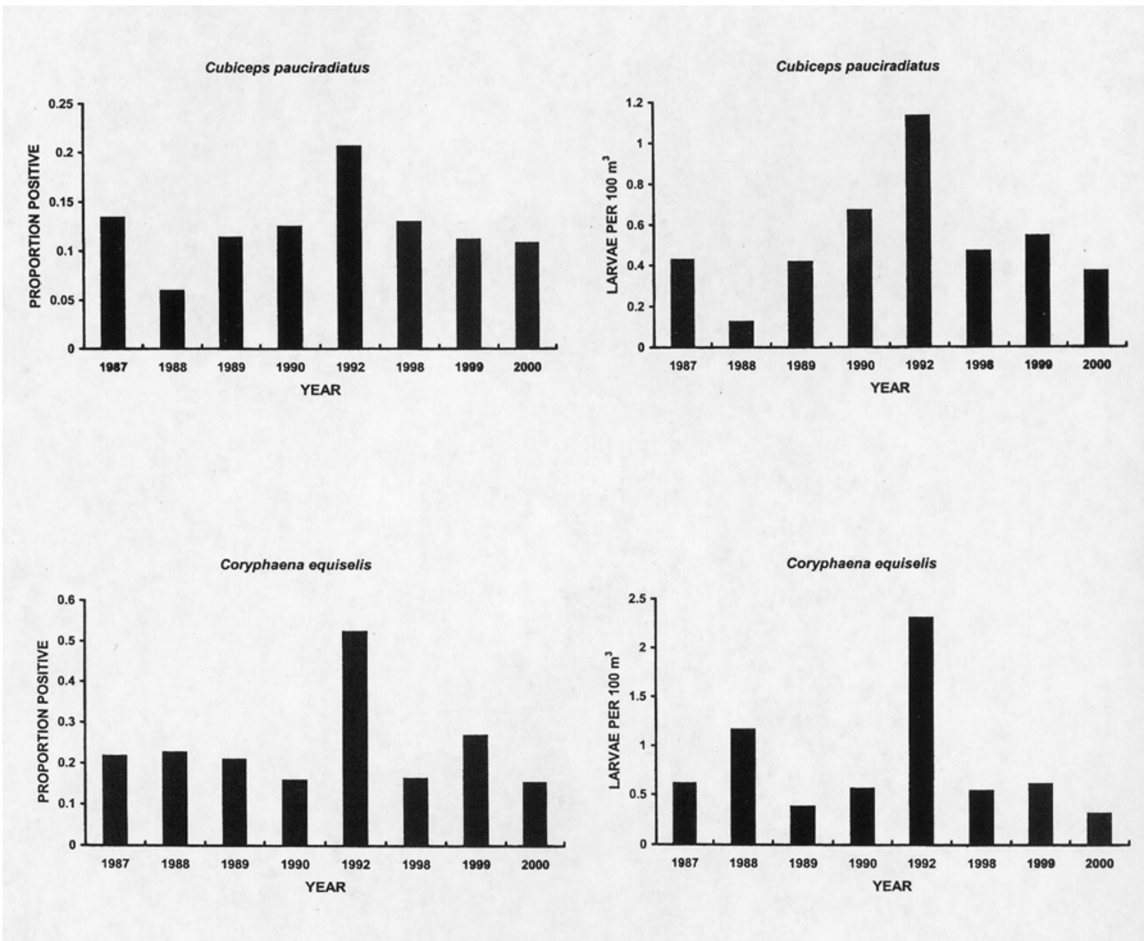

Figure 21. Average occurrence (proportion of positive tows) and abundance (larvae per 100 m^3) of *Cubiceps pauciradiatus* (above) and *Coryphaena equiselis* (below) larvae taken in Manta net tows during eight surveys (1987–2000) in the eastern tropical Pacific.

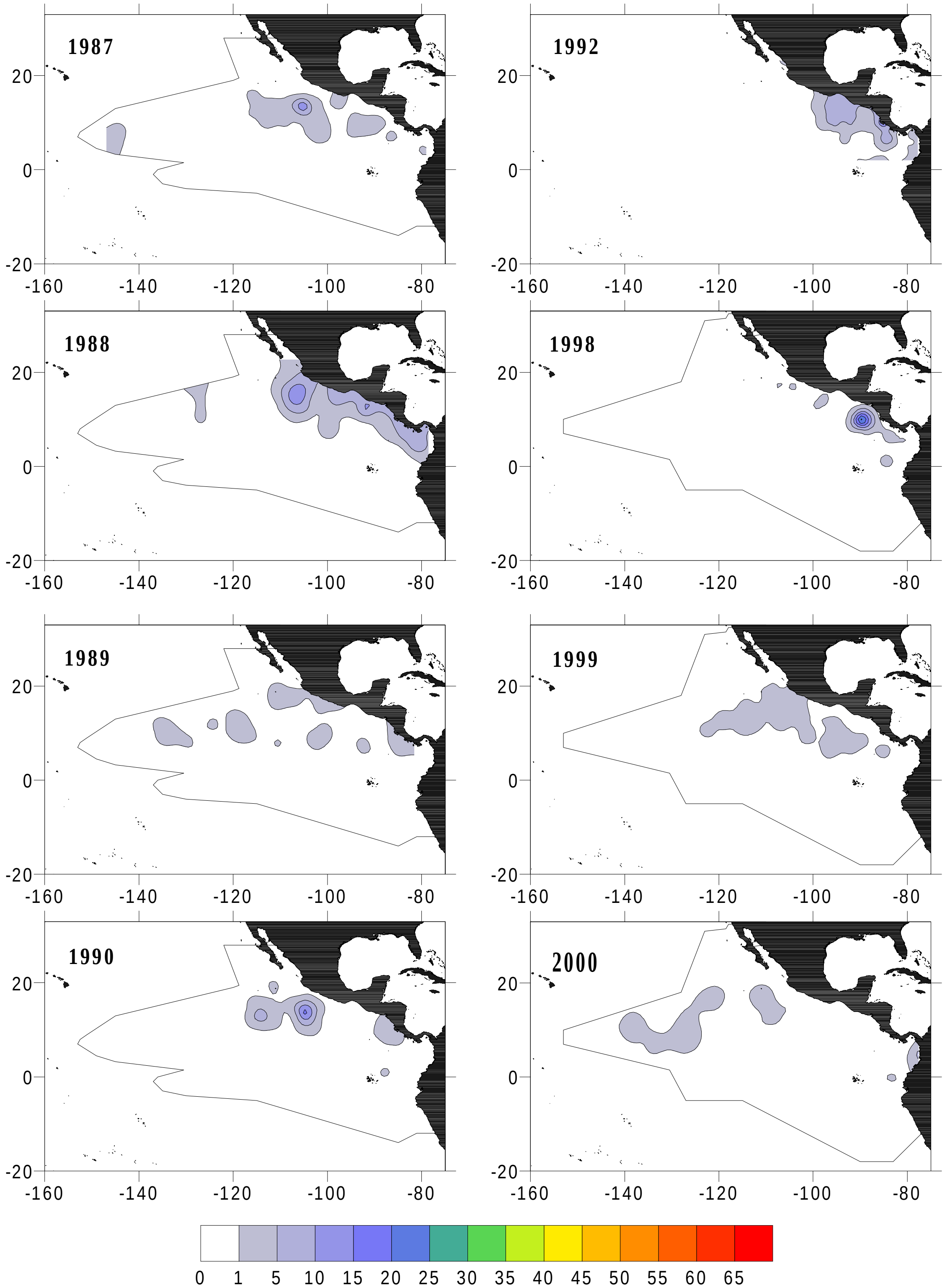

Figure 22. Contour maps of average abundance *Coryphaena equiselis* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 5 larvae/100 m^3 of water filtered.

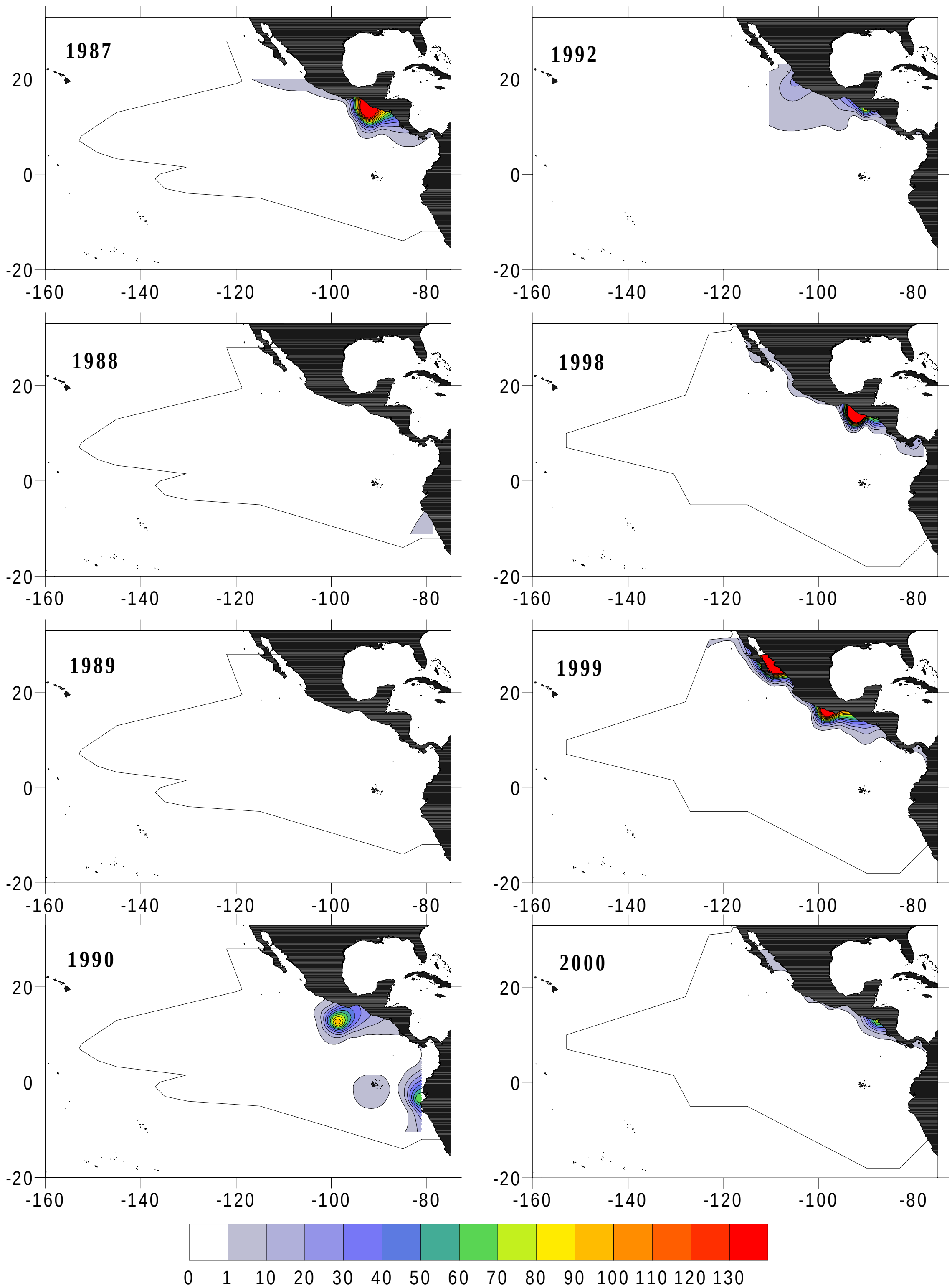

Figure 23. Contour maps of average abundance *Opisthonema* spp. larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 10 larvae/100 m^3 of water filtered.

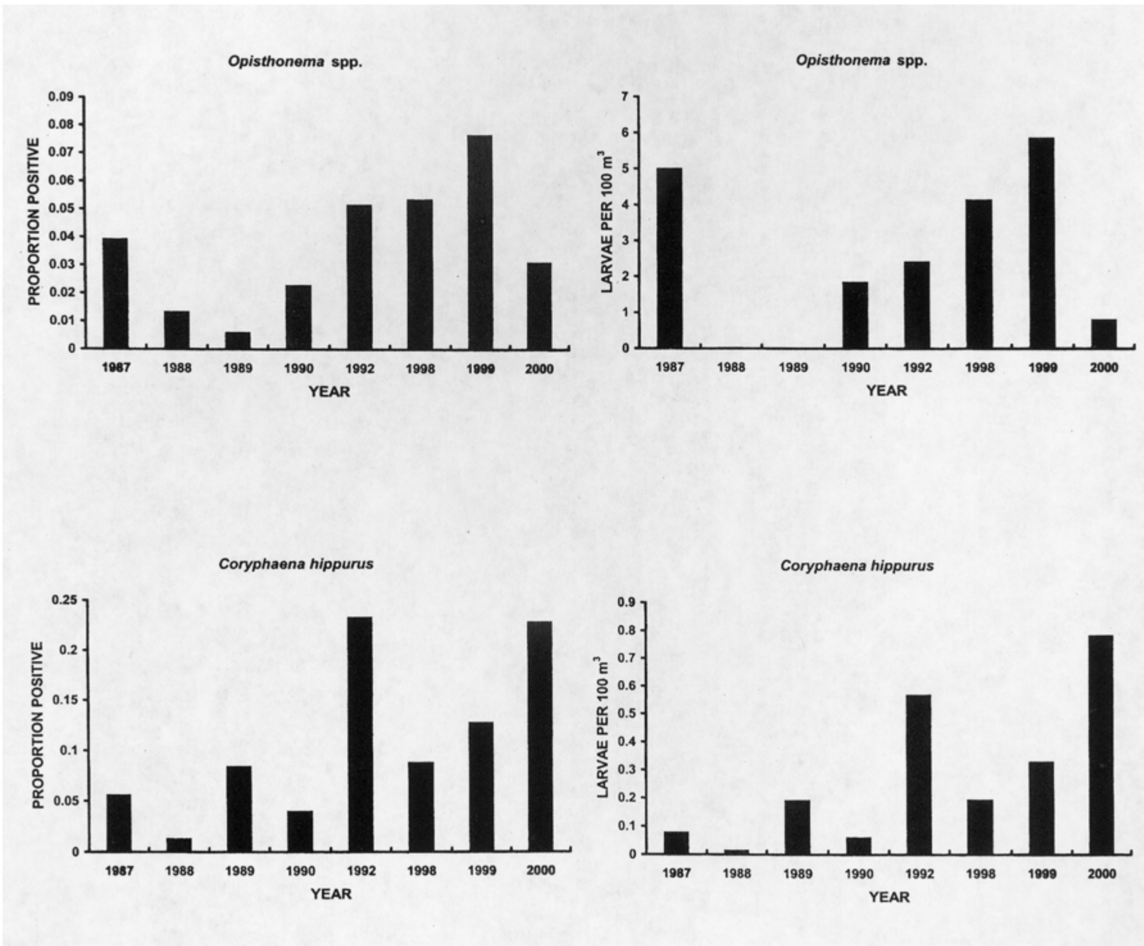

Figure 24. Average occurrence (proportion of positive tows) and abundance (larvae per 100 m^3) of *Opisthonema* spp. (above) and *Coryphaena hippurus* (below) larvae taken in Manta net tows during eight surveys (1987–2000) in the eastern tropical Pacific.

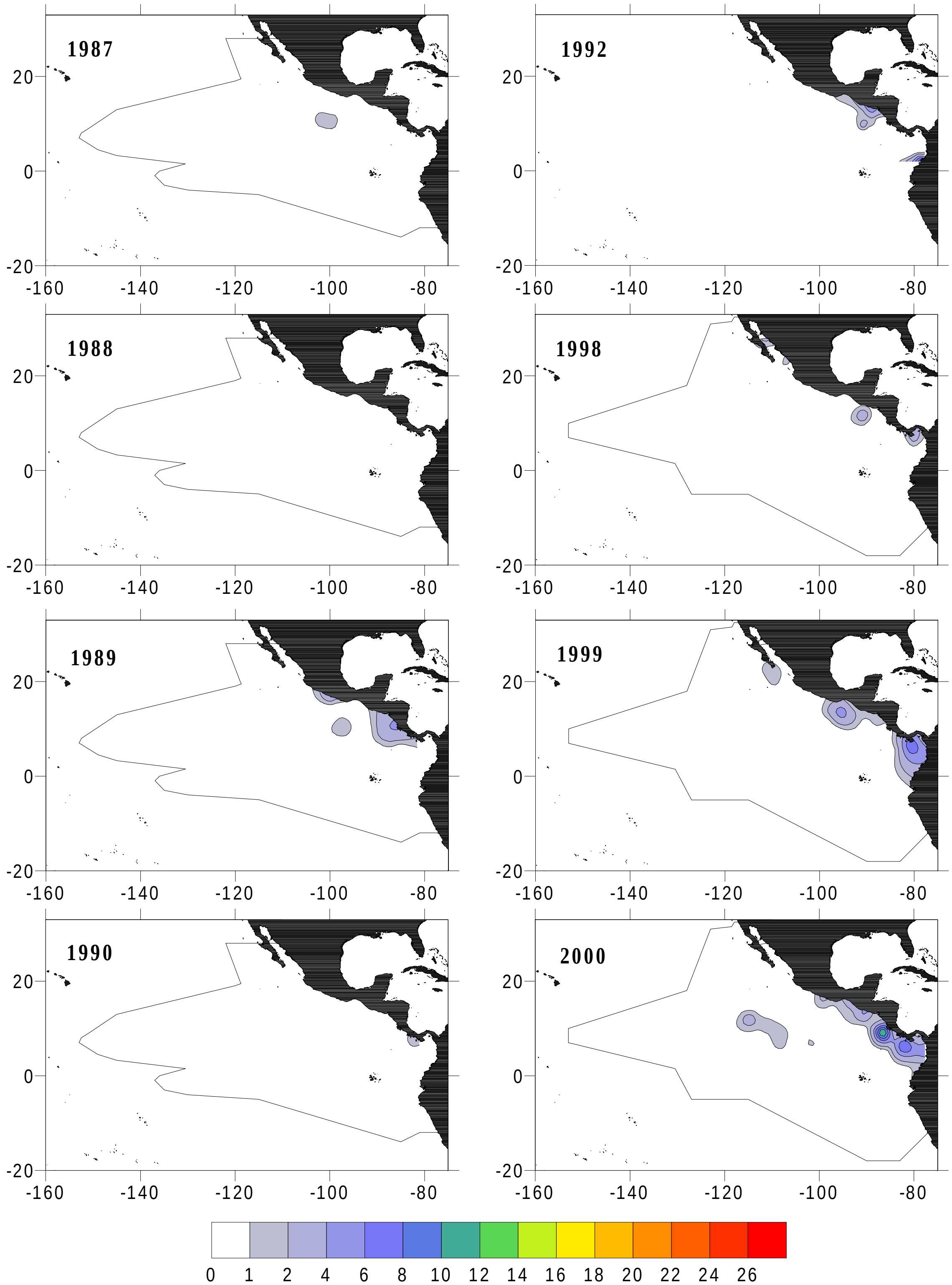

Figure 25. Contour maps of average abundance of *Coryphaena hippurus* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 2 larvae/100 m^3 of water filtered.

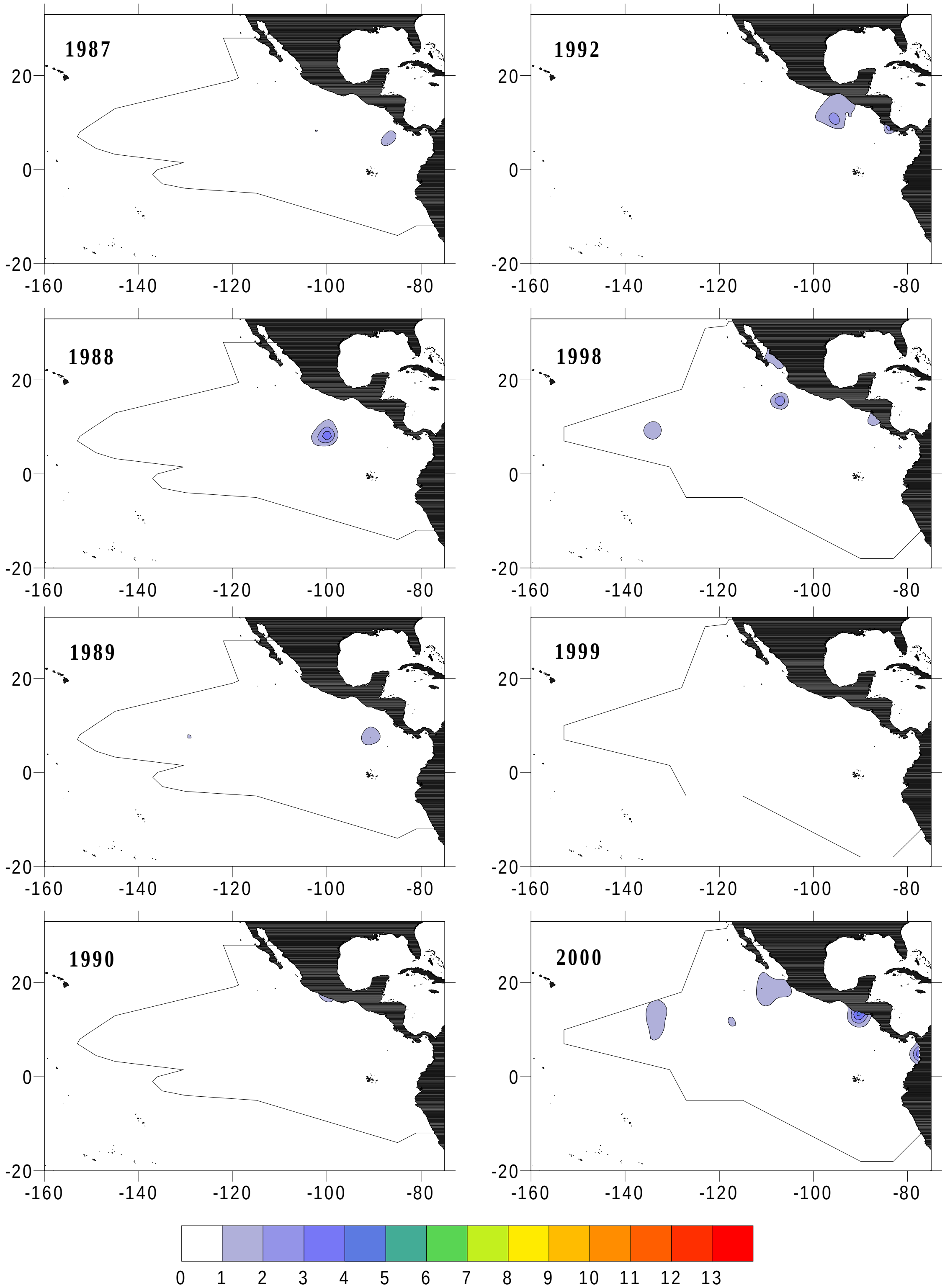

Figure 26. Contour maps of average abundance of *Cheilopogon xenopterus* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour represents 1 larva/100 m^3 of water filtered.

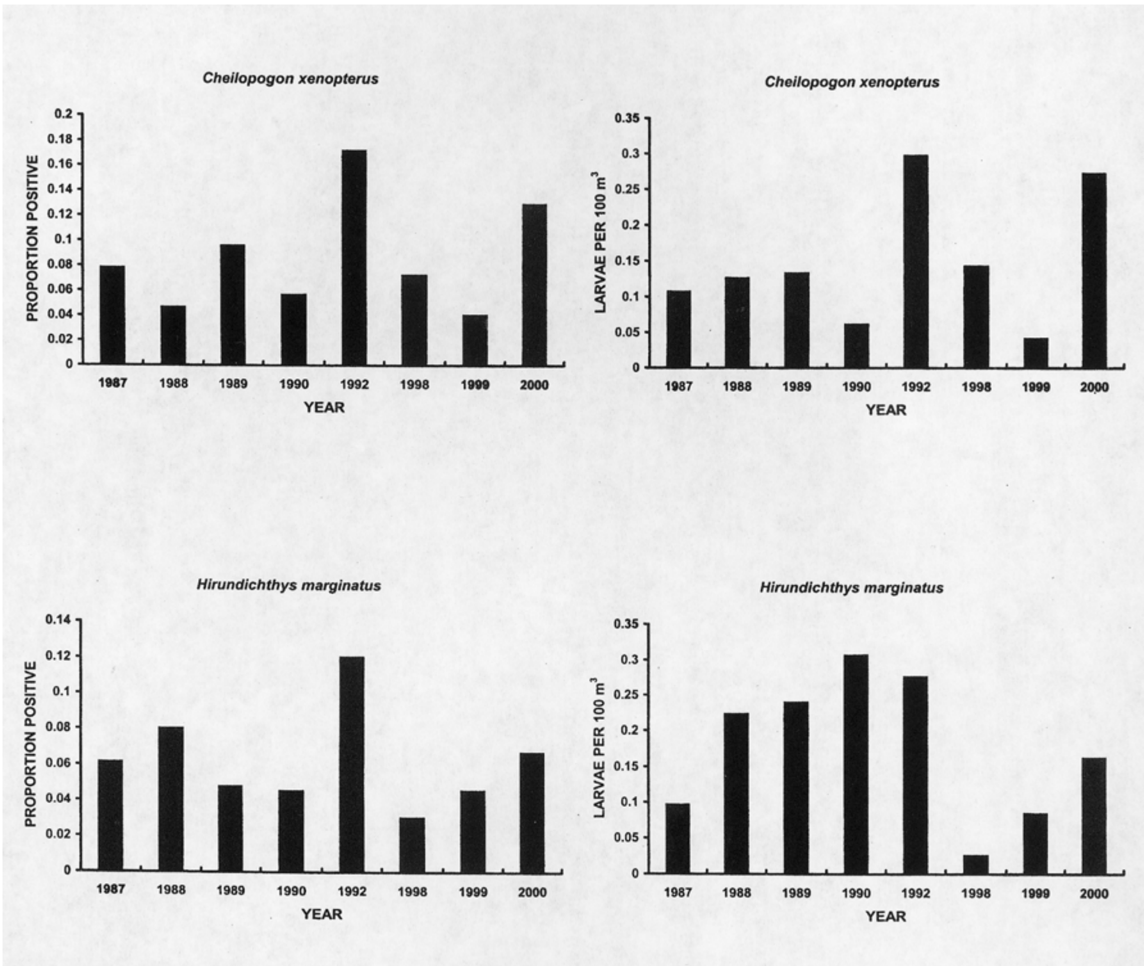

Figure 27. Average occurrence (proportion of positive tows) and abundance (larvae per 100 m^3) of *Cheilopogon xenopterus* (above)and *Hirundichthys marginatus* (below) larvae taken in Manta net tows during eight surveys (1987–2000) in the eastern tropical Pacific.

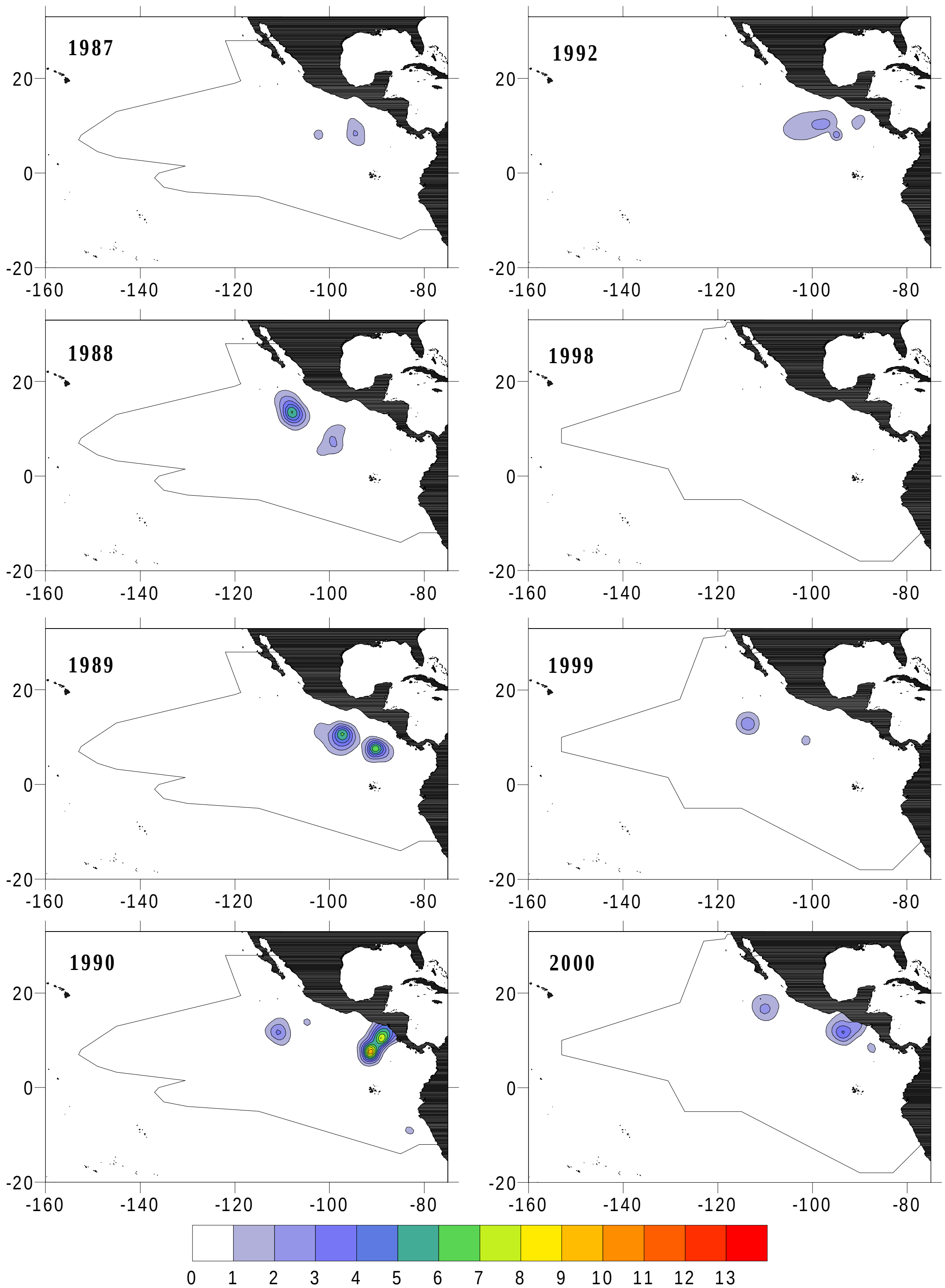

Figure 28. Contour maps of average abundance of *Hirundichthys marginatus* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 1 larva/100 m^3 of water filtered.

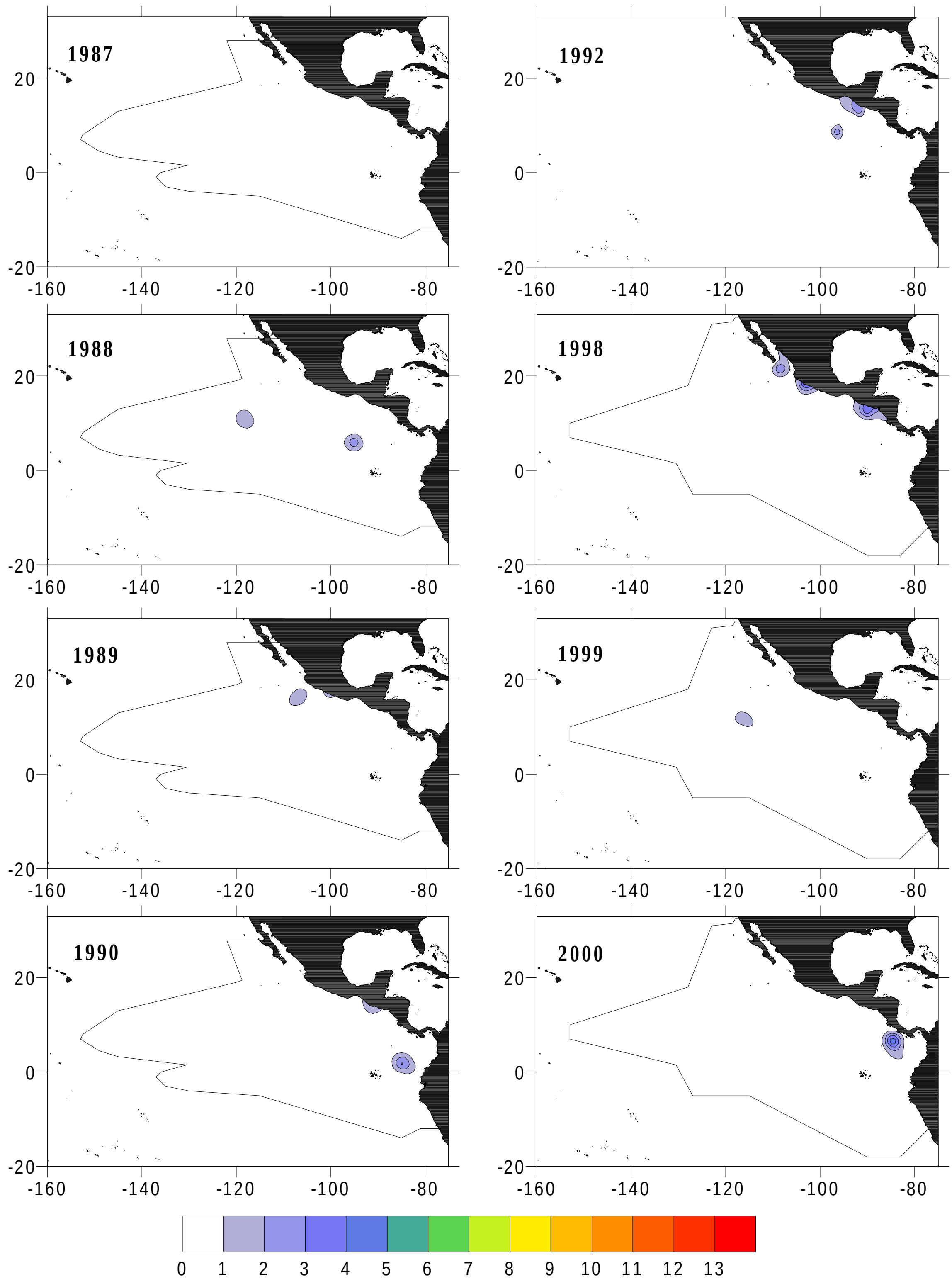

Figure 29. Contour maps of average abundance of *Thunnus* spp. larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour represents 1 larva/100 m^3 of water filtered.

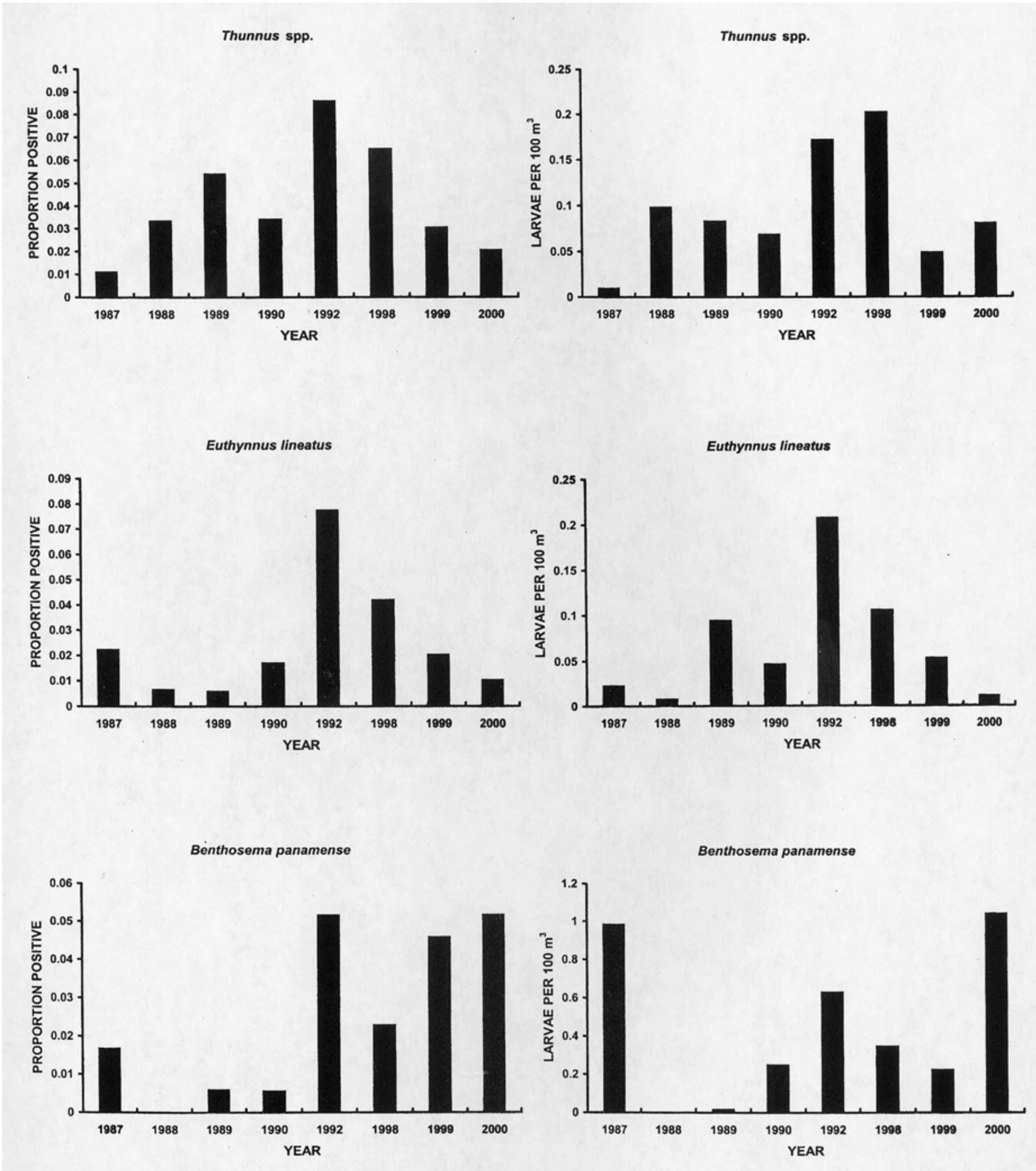

Figure 30. Average occurrence (proportion of positive tows) and abundance (larvae per 100 m^3) of *Thunnus* spp. (above), *Euthynnus lineatus* (middle) and *Benthosema panamense* (below) larvae taken in Manta net tows during eight surveys (1987–2000) in the eastern tropical Pacific.

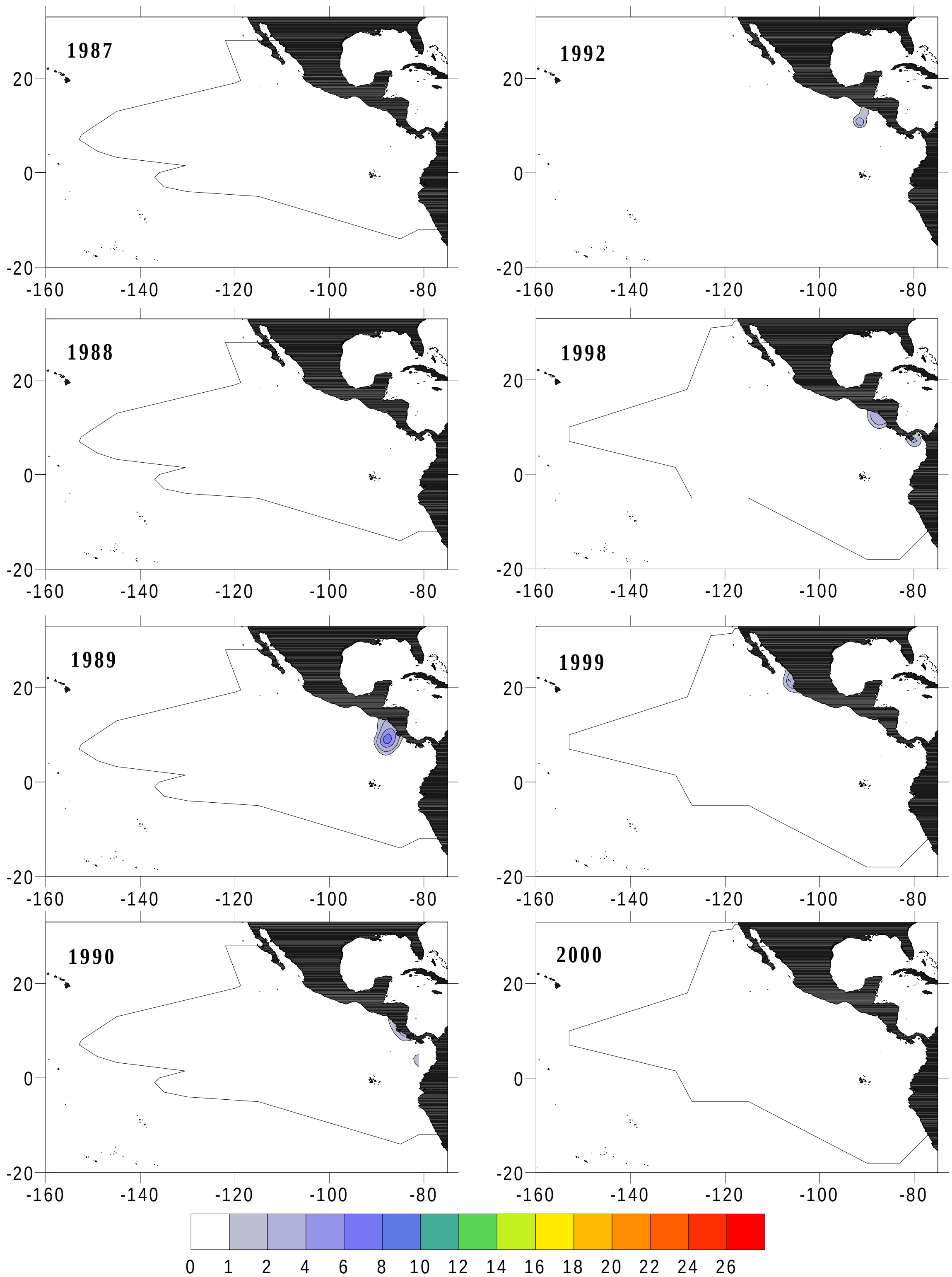

Figure 31. Contour maps of average abundance of *Euthynnus lineatus* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 2 larvae/100 m^3 of water filtered.

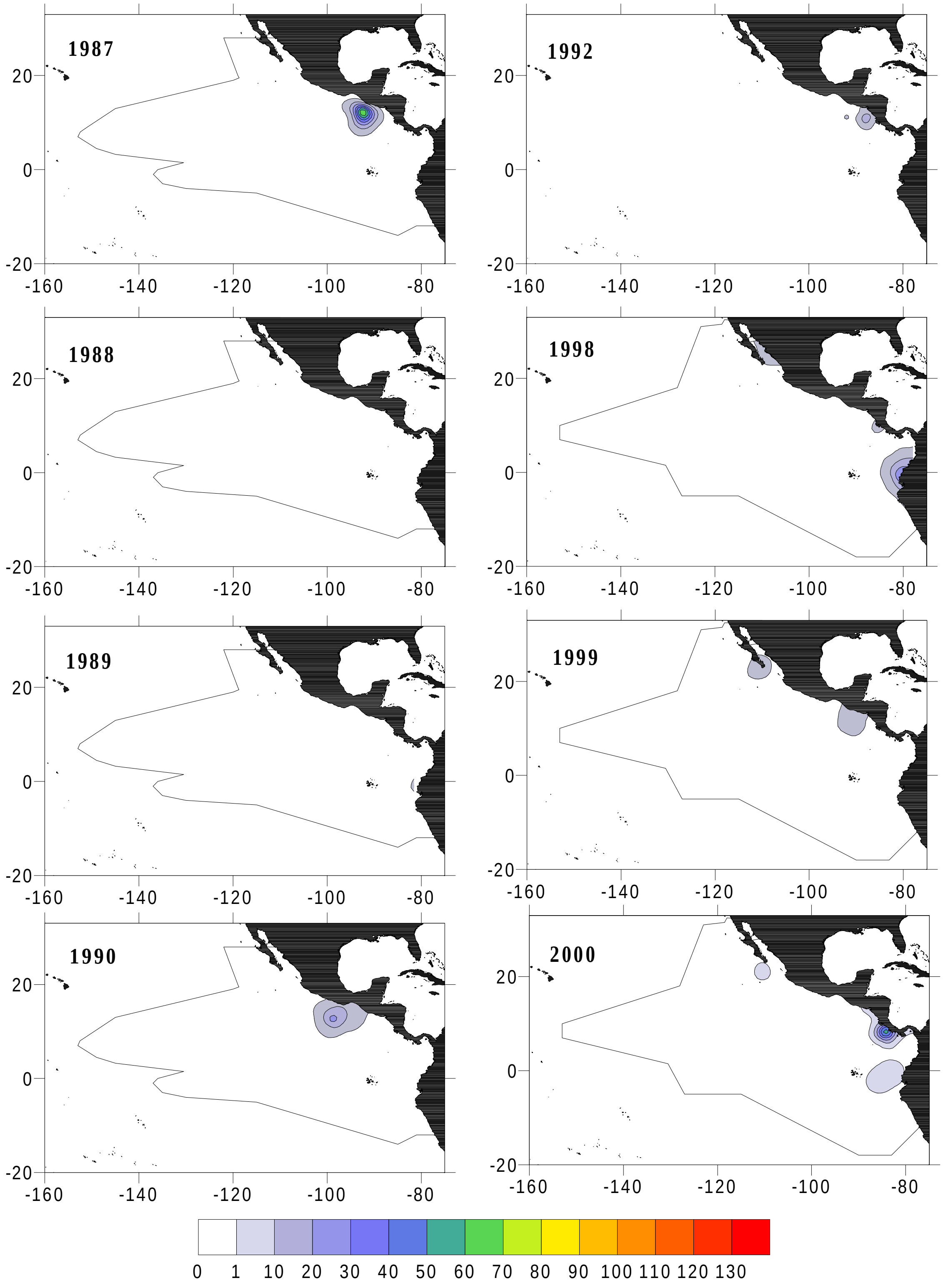

Figure 32. Contour maps of average abundance of *Benthosema panamense* larvae from Manta net tows taken on eight surveys (1987–2000) in the eastern tropical Pacific. Each contour interval represents 10 larvae/100 m^3 of water filtered.

Table 1. Numbers of Manta tows taken in each region during Marine Mammal Division surveys in the eastern tropical Pacific in 1987–2000.

YEAR	REGION											
	1	2	3	4	5	6	7	8	9	10	11	Total
1987	6	6	39	39	37	10	6	14	13	5	3	178
1988	3	7	33	36	28	8	4	12	12	3	3	149
1989	9	14	26	40	27	8	5	16	12	9	0	166
1990	5	17	31	34	39	14	3	17	12	3	0	175
1992	3	1	100	12	0	0	0	0	0	0	0	116
1998	29	31	57	40	38	20	7	25	10	4	0	261
1999	17	36	35	36	28	15	7	20	0	2	0	196
2000	17	27	37	34	26	13	6	17	8	6	2	193
Total	89	139	358	271	223	88	38	121	67	32	8	1434

Table 2. Pooled occurrences of fish larvae taken in Manta net tows during Marine Mammal Division surveys in the eastern tropical Pacific during 1987–2000.

Rank	Taxon	Occurrences
1	*Vinciguerria lucetia*	566
2	*Oxyporhamphus micropterus*	520
3	*Coryphaena equiselis*	323
4	*Auxis* spp.	314
5	*Prognichthys* spp.	180
6	*Cubiceps pauciradiatus*	175
7	*Coryphaena hippurus*	152
8	*Cheilopogon xenopterus*	119
9	*Exocoetus* spp.	98
10	*Hirundichthys marginatus*	83
11	*Mugil* spp.	77
11	Scomberesocidae	77
13	Gerreidae	70
14	*Lampanyctus* spp.	66
15	*Lampanyctus parvicauda*	63
16	*Hirundichthys* spp.	60
17	*Thunnus* spp.	59
18	*Opisthonema* spp.	55
19	*Caranx caballus*	51
20	*Lestidium* spp.	50
20	*Naucrates ductor*	50
22	*Polydactylus approximans*	47
22	*Cyclothone* spp.	47
24	*Diplophos proximus*	42
25	Gobiidae	40
26	*Diaphus* spp.	37
27	*Benthosema panamense*	36
28	*Euthynnus lineatus*	35
29	*Canthidermis maculatus*	32
29	*Bothus* spp.	32
31	*Howella pammelas*	31
32	*Cheilopogon* spp.	30
33	*Nealotus tripes*	25
34	*Cololabis saira*	24
34	*Cetengraulis mysticetus*	24
36	*Anchoa* spp.	19
36	Haemulidae	19
36	*Myctophum aurolaternatum*	19
39	*Hygophum proximum*	18
39	*Symphurus* spp.	18
41	*Psenes sio*	17
41	Sciaenidae	17
41	*Ariosoma gilberti*	17
44	*Elassichthys adocetus*	16
44	*Nomeus gronovii*	16
44	*Brama dussumieri*	16
47	Engraulidae	15
47	Disintegrated fish larvae	15
49	Unidentified	14

Table 2. (cont.)

Rank	Taxon	Occurrences
49	*Fodiator acutus*	14
51	*Ceratoscopelus warmingii*	13
52	*Scomberesox saurus*	12
52	*Oneirodes* spp.	12
52	*Hemiramphus saltator*	12
55	*Melanocetus* spp.	11
56	*Caranx sexfasciatus*	10
56	*Symbolophorus evermanni*	10
56	*Hygophum atratum*	10
56	*Triphoturus* spp.	10
56	*Katsuwonus pelamis*	10
61	*Scomber japonicus*	9
61	*Synodus* spp.	9
61	*Chiasmodon niger*	9
61	*Trachipterus fukuzakii*	9
61	*Microspathodon* spp.	9
61	*Trachinotus kennedyi*	9
61	*Psenes cyanophrys*	9
61	Eleotridae	9
61	*Syacium ovale*	9
70	*Cyclothone signata*	8
70	*Scorpaena* spp.	8
70	*Gigantactis* spp.	8
70	*Chloroscombrus orqueta*	8
70	*Selar crumenophthalmus*	8
70	*Synodus evermanni*	8
70	*Bregmaceros* spp.	8
70	*Istiophorus platypterus*	8
70	Carangidae	8
70	*Gempylus serpens*	8
70	*Stemonosudis macrura*	8
81	*Caranx* spp.	7
81	*Lutjanus* spp.	7
81	*Seriola* spp.	7
81	*Lobotes surinamensis*	7
81	*Cheilopogon heterurus*	7
81	Pomacentridae	7
81	*Engraulis ringens*	7
88	Myctophidae	6
88	*Mugil cephalus*	6
88	*Synodus sechurae*	6
88	*Trichiurus lepturus*	6
88	Epinephelinae	6
88	*Entomacrodus chiostictus*	6
88	*Gymnothorax mordax*	6
88	*Citharichthys platophrys*	6
88	*Cyclothone acclinidens*	6
88	*Coryphaena* spp.	6
88	*Trachinotus paitensis*	6
88	*Bregmaceros bathymaster*	6

Table 2. (cont.)

Rank	Taxon	Occurrences
88	*Sternoptyx* spp.	6
88	*Lactoria diaphana*	6
88	Exocoetidae	6
88	*Bathophilus filifer*	6
104	*Zu cristatus*	5
104	*Monolene* spp.	5
104	*Psenes pellucidus*	5
104	*Oligoplites* spp.	5
104	*Alectis ciliaris*	5
104	*Diogenichthys laternatus*	5
104	Mullidae	5
104	*Trachinotus rhodopus*	5
104	*Bolinichthys* spp.	5
104	*Hypsoblennius* spp.	5
104	*Lampadena urophaos*	5
104	*Exocoetus monocirrhus*	5
104	*Exocoetus volitans*	5
104	*Lestidiops neles*	5
104	*Polydactylus opercularis*	5
119	*Cheilopogon pinnatibarbatus*	4
119	*Scopelogadus bispinosus*	4
119	*Triphoturus nigrescens*	4
119	*Pontinus* spp.	4
119	Ophidiidae	4
119	*Bolinichthys longipes*	4
119	Serraninae	4
119	*Albula* spp.	4
119	*Sargocentron suborbitalis*	4
119	*Syacium* spp.	4
119	*Haemulon* spp.	4
119	*Kyphosus* spp.	4
119	*Microdesmus* spp.	4
119	Kyphosidae	4
119	*Pronotogrammus multifasciatus*	4
119	Scorpaenidae	4
135	*Dolopichthys* spp.	3
135	Anguilliformes	3
135	*Oligoplites saurus*	3
135	*Sarda chiliensis*	3
135	*Diodon hystrix*	3
135	Clupeidae	3
135	*Ophichthus zophochir*	3
135	*Decapterus* spp.	3
135	*Hypsoblennius jenkinsi*	3
135	*Sardinops sagax*	3
135	Labridae	3
135	*Diaphus pacificus*	3
135	Balistidae	3
135	*Xenistius californiensis*	3
135	*Ceratoscopelus* spp.	3

Table 2. (cont.)

Rank	Taxon	Occurrences
135	*Lutjanus peru*	3
135	Serranidae	3
135	*Myctophum nitidulum*	3
135	*Amarsipus carlsbergi*	3
135	*Etropus crossotus*	3
135	*Seriola lalandi*	3
135	*Cubiceps baxteri*	3
135	Melanostomiinae	3
135	Astronesthinae	3
135	*Cyclothone pseudopallida*	3
135	*Scomberomorus sierra*	3
135	*Lepophidium* spp.	3
135	*Etropus* spp.	3
163	*Tetragonurus atlanticus*	2
163	*Balistes polylepis*	2
163	Ophichthidae	2
163	*Ophichthus* spp.	2
163	*Harengula thrissina*	2
163	*Diodon* spp.	2
163	*Engraulis mordax*	2
163	*Chanos chanos*	2
163	*Ostracion meleagris*	2
163	*Diplophos taenia*	2
163	*Etropus peruvianus*	2
163	*Synodus scituliceps*	2
163	*Tetragonurus cuvieri*	2
163	*Ceratoscopelus townsendi*	2
163	*Diogenichthys atlanticus*	2
163	*Hygophum reinhardtii*	2
163	*Myripristis leiognathos*	2
163	*Myctophum lychnobium*	2
163	*Trachipterus altivelis*	2
163	*Cyclopsetta panamensis*	2
163	*Centrophryne spinulosa*	2
163	*Cyclopsetta* spp.	2
163	*Synodus lucioceps*	2
163	*Apogon* spp.	2
163	*Nematistius pectoralis*	2
163	Scombridae	2
163	Istiophoridae	2
163	*Pteraclis aesticola*	2
163	*Acanthocybium solandri*	2
163	Lutjanidae	2
163	*Eucinostomus* spp.	2
163	Chiasmodontidae	2
163	*Calamus brachysomus*	2
163	*Medialuna californiensis*	2
163	*Synchiropus atrilabiatus*	2
163	*Labrisomus multiporosus*	2
163	*Pristigenys serrula*	2

Table 2. (cont.)

Rank	Taxon	Occurrences
163	*Stegastes* spp.	2
163	*Luvarus imperialis*	2
163	*Sphyraena ensis*	2
163	*Centropomus* spp.	2
163	*Chromis punctipinnis*	2
163	*Scorpaenodes xyris*	2
163	*Chaetodipterus zonatus*	2
163	*Lythrypnus* spp.	2
163	Acanthuridae	2
163	Perciformes	2
210	*Scarus* spp.	1
210	Labrisomidae	1
210	*Abudefduf declivifrons*	1
210	*Astronesthes* spp.	1
210	*Abudefduf troschelii*	1
210	*Ammodytoides gilli*	1
210	*Halichoeres semicinctus*	1
210	*Scopelengys tristis*	1
210	*Synodus lacertinus*	1
210	*Evermannella ahlstromi*	1
210	Scaridae	1
210	*Xyrichtys* spp.	1
210	*Stomias* spp.	1
210	Paralepididae	1
210	*Hypsypops rubicundus*	1
210	*Lestidiops* spp.	1
210	*Pseudoscopelus* spp.	1
210	*Ophioblennius steindachneri*	1
210	Muraenidae	1
210	*Gymnothorax* spp.	1
210	*Ptereleotris* spp.	1
210	*Clarkichthys bilineatus*	1
210	Congridae	1
210	*Mola mola*	1
210	*Paraconger californiensis*	1
210	Clupeiformes	1
210	*Sphyraena* spp.	1
210	*Etrumeus teres*	1
210	*Erotelis armiger*	1
210	*Dormitator latifrons*	1
210	*Diodon holocanthus*	1
210	*Vinciguerria* spp.	1
210	Dactyloscopidae	1
210	*Vinciguerria poweriae*	1
210	*Labrisomus* spp.	1
210	*Abudefduf* spp.	1
210	*Argyropelecus sladeni*	1
210	*Nannobrachium ritteri*	1
210	*Scartichthys* spp.	1
210	*Lactoria fornasini*	1

Table 2. (cont.)

Rank	Taxon	Occurrences
210	Tetraodontidae	1
210	Blenniidae	1
210	*Hypsoblennius brevipinnis*	1
210	*Hypsoblennius gentilis*	1
210	*Hypsoblennius gilberti*	1
210	*Hypsoblennius proteus*	1
210	Stomiinae	1
210	*Paraclinus* spp.	1
210	Priacanthidae	1
210	*Hemicaranx* spp.	1
210	*Gobiesox eugrammus*	1
210	Atherinidae	1
210	*Atherinella* spp.	1
210	*Gnathanodon speciosus*	1
210	*Elagatis bipinnulatus*	1
210	*Citharichthys* spp.	1
210	Paralichthyidae	1
210	*Strongylura exilis*	1
210	Hemiramphidae	1
210	*Phtheirichthys lineatus*	1
210	*Perissias taeniopterus*	1
210	*Cheilopogon dorsomaculata*	1
210	*Selene peruviana*	1
210	Opisthognathidae	1
210	*Hemanthias signifer*	1
210	*Paralabrax* spp.	1
210	*Psenes* spp.	1
210	*Sarda orientalis*	1
210	*Howella* spp.	1
210	*Hirundichthys speculiger*	1
210	Triglidae	1
210	*Prognichthys tringa*	1
210	*Melamphaes* spp.	1
210	*Scorpaena guttata*	1
210	*Sebastes* spp.	1
210	Apogonidae	1
210	*Pomadasys* spp.	1
210	*Mugil curema*	1
210	*Symphurus elongatus*	1
210	Mugilidae	1
210	*Cheilodactylus* spp.	1
210	Cynoglossidae	1
210	*Myripristis* spp.	1
210	*Lobianchia gemellarii*	1
210	*Notoscopelus resplendens*	1
210	*Stenobrachius leucopsarus*	1
210	Chaetodontidae	1
210	*Sectator ocyurus*	1
210	Bothidae	1
210	*Ceratias holboelli*	1

Table 2. (cont.)

Rank	Taxon	Occurrences
210	*Menticirrhus* spp.	1
210	*Selene* spp.	1
210	Trichiuridae	1
210	*Myctophum asperum*	1
210	*Lutjanus novemfasciatus*	1
210	*Caristius maderensis*	1
210	Bramidae	1
210	*Trachurus symmetricus*	1
210	*Seriola rivoliana*	1
210	Bythitidae	1
210	Ogcocephalidae	1
210	*Zalieutes elater*	1
210	*Seriola peruana*	1
210	*Sphyraena argentea*	1
210	*Centrobranchus nigroocellatus*	1
	Total	4786

Table 3. Total abundance (raw counts) of fish larvae taken in Manta net tows during Marine Mammal Division surveys in the eastern tropical Pacific during 1987–2000.

Rank	Taxon	Count
1	*Vinciguerria lucetia*	6209
2	*Opisthonema* spp.	3874
3	*Oxyporhamphus micropterus*	3283
4	*Auxis* spp.	2689
5	*Cetengraulis mysticetus*	1568
6	*Prognichthys* spp.	1273
7	Scomberesocidae	1136
8	*Coryphaena equiselis*	1097
9	Engraulidae	806
10	*Benthosema panamense*	656
11	*Cubiceps pauciradiatus*	651
12	*Polydactylus approximans*	555
13	*Anchoa* spp.	528
14	*Elassichthys adocetus*	494
15	*Mugil* spp.	419
16	*Coryphaena hippurus*	375
17	Gerreidae	328
17	*Scomber japonicus*	328
19	*Hirundichthys* spp.	271
20	*Scomberesox saurus*	239
21	*Hirundichthys marginatus*	214
22	Gobiidae	196
23	*Cheilopogon xenopterus*	184
24	*Lampanyctus* spp.	156
25	*Caranx caballus*	155
25	*Etrumeus teres*	155
27	*Exocoetus* spp.	152
28	Sciaenidae	129
29	*Thunnus* spp.	120
30	*Engraulis ringens*	118
31	*Lampanyctus parvicauda*	104
32	*Cololabis saira*	98
33	*Sardinops sagax*	95
34	*Euthynnus lineatus*	90
35	*Lestidium* spp.	88
36	*Cheilopogon* spp.	86
37	Haemulidae	85
38	*Cyclothone* spp.	84
39	*Hemiramphus saltator*	78
40	*Bothus* spp.	75
41	*Bregmaceros bathymaster*	73
42	*Canthidermis maculatus*	72
43	*Naucrates ductor*	64
44	*Diaphus* spp.	61
45	*Symphurus* spp.	58
46	*Nealotus tripes*	55
46	*Ariosoma gilberti*	55
48	*Diplophos proximus*	50
49	*Howella pammelas*	45

Table 3. (cont.)

Rank	Taxon	Count
50	*Trachinotus kennedyi*	41
51	*Oligoplites* spp.	39
52	*Polydactylus opercularis*	38
53	*Ceratoscopelus warmingii*	37
54	*Pronotogrammus multifasciatus*	35
54	*Hygophum proximum*	35
54	*Myctophum aurolaternatum*	35
57	*Chloroscombrus orqueta*	33
58	*Mugil cephalus*	27
59	*Fodiator acutus*	26
59	*Psenes sio*	26
61	Mullidae	25
62	*Trichiurus lepturus*	24
63	Carangidae	23
64	*Scorpaena* spp.	21
64	*Lobotes surinamensis*	21
66	*Haemulon* spp.	20
67	*Hygophum atratum*	19
67	*Brama dussumieri*	19
67	*Synodus evermanni*	19
70	*Nomeus gronovii*	18
71	*Cheilopogon heterurus*	17
71	Disintegrated fish larvae	17
71	Eleotridae	17
71	*Syacium* spp.	17
75	*Caranx sexfasciatus*	16
75	Unidentified	16
75	*Triphoturus* spp.	16
75	*Scomberomorus sierra*	16
79	*Selar crumenophthalmus*	15
79	*Syacium ovale*	15
79	*Oneirodes* spp.	15
79	*Cyclothone signata*	15
79	*Trachinotus rhodopus*	15
84	*Katsuwonus pelamis*	14
84	*Mugil curema*	14
84	*Bregmaceros* spp.	14
84	Clupeiformes	14
84	*Pontinus* spp.	14
84	Serraninae	14
90	*Lutjanus peru*	13
91	*Microspathodon* spp.	12
91	*Synodus* spp.	12
91	*Lutjanus* spp.	12
91	*Trachinotus paitensis*	12
95	*Gempylus serpens*	11
95	*Scarus* spp.	11
95	*Melanocetus* spp.	11
95	Clupeidae	11
95	*Symbolophorus evermanni*	11

Table 3. (cont.)

Rank	Taxon	Count
95	*Trachipterus fukuzakii*	11
95	*Caranx* spp.	11
95	*Chiasmodon niger*	11
95	*Sargocentron suborbitalis*	11
104	*Synodus sechurae*	10
104	*Psenes cyanophrys*	10
104	*Coryphaena* spp.	10
104	Paralichthyidae	10
104	*Hypsoblennius jenkinsi*	10
104	*Entomacrodus chiostictus*	10
110	Kyphosidae	9
110	Lutjanidae	9
110	*Microdesmus* spp.	9
110	*Chromis punctipinnis*	9
110	*Istiophorus platypterus*	9
110	*Stemonosudis macrura*	9
110	*Albula* spp.	9
110	*Citharichthys platophrys*	9
110	*Eucinostomus* spp.	9
110	*Sphyraena ensis*	9
120	*Xenistius californiensis*	8
120	Myctophidae	8
120	*Cyclopsetta panamensis*	8
120	*Bolinichthys longipes*	8
120	Epinephelinae	8
120	*Gigantactis* spp.	8
126	*Seriola* spp.	7
126	*Sternoptyx* spp.	7
126	*Lactoria diaphana*	7
126	*Etropus* spp.	7
126	*Gymnothorax mordax*	7
126	*Apogon* spp.	7
126	*Cyclothone acclinidens*	7
126	Atherinidae	7
126	*Alectis ciliaris*	7
126	Pomacentridae	7
126	*Diogenichthys laternatus*	7
126	*Cubiceps baxteri*	7
126	*Centropomus* spp.	7
139	*Sectator ocyurus*	6
139	Exocoetidae	6
139	*Chanos chanos*	6
139	*Synodus scituliceps*	6
139	*Bathophilus filifer*	6
139	*Lestidiops neles*	6
139	*Lampadena urophaos*	6
139	*Synodus lucioceps*	6
139	*Psenes pellucidus*	6
148	*Zu cristatus*	5
148	*Sarda chiliensis*	5

Table 3. (cont.)

Rank	Taxon	Count
148	*Cheilopogon pinnatibarbatus*	5
148	*Hypsoblennius* spp.	5
148	*Diodon hystrix*	5
148	*Exocoetus volitans*	5
148	*Bolinichthys* spp.	5
148	*Exocoetus monocirrhus*	5
148	*Menticirrhus* spp.	5
148	*Prognichthys tringa*	5
148	*Monolene* spp.	5
148	*Kyphosus* spp.	5
148	*Paralabrax* spp.	5
161	*Ceratoscopelus* spp.	4
161	*Scopelogadus bispinosus*	4
161	*Diaphus pacificus*	4
161	*Labrisomus multiporosus*	4
161	Serranidae	4
161	Ophidiidae	4
161	*Engraulis mordax*	4
161	*Myctophum nitidulum*	4
161	*Paraclinus* spp.	4
161	*Triphoturus nigrescens*	4
161	*Oligoplites saurus*	4
161	*Decapterus* spp.	4
161	Mugilidae	4
161	Labridae	4
161	Acanthuridae	4
161	*Seriola lalandi*	4
161	*Chaetodipterus zonatus*	4
161	Scorpaenidae	4
161	Melanostomiinae	4
180	*Ophichthus zophochir*	3
180	*Trachurus symmetricus*	3
180	*Etropus peruvianus*	3
180	*Myripristis leiognathos*	3
180	*Lepophidium* spp.	3
180	Balistidae	3
180	*Etropus crossotus*	3
180	*Dolopichthys* spp.	3
180	*Citharichthys* spp.	3
180	Astronesthinae	3
180	Anguilliformes	3
180	*Gymnothorax* spp.	3
180	*Hypsypops rubicundus*	3
180	*Cyclopsetta* spp.	3
180	*Balistes polylepis*	3
180	*Harengula thrissina*	3
180	*Diodon holocanthus*	3
180	*Cyclothone pseudopallida*	3
180	*Clarkichthys bilineatus*	3

Table 3. (cont.)

Rank	Taxon	Count
180	*Acanthocybium solandri*	3
180	*Vinciguerria poweriae*	3
180	*Amarsipus carlsbergi*	3
180	Ophichthidae	3
203	*Stenobrachius leucopsarus*	2
203	Istiophoridae	2
203	*Ceratoscopelus townsendi*	2
203	*Stegastes* spp.	2
203	*Astronesthes* spp.	2
203	*Luvarus imperialis*	2
203	*Diogenichthys atlanticus*	2
203	*Tetragonurus atlanticus*	2
203	*Centrophryne spinulosa*	2
203	*Notoscopelus resplendens*	2
203	*Hygophum reinhardtii*	2
203	*Myctophum lychnobium*	2
203	*Tetragonurus cuvieri*	2
203	*Calamus brachysomus*	2
203	*Pteraclis aesticola*	2
203	Scombridae	2
203	*Halichoeres semicinctus*	2
203	*Pseudoscopelus* spp.	2
203	*Synchiropus atrilabiatus*	2
203	*Diplophos taenia*	2
203	*Lythrypnus* spp.	2
203	*Scorpaenodes xyris*	2
203	*Diodon* spp.	2
203	Perciformes	2
203	*Medialuna californiensis*	2
203	*Ostracion meleagris*	2
203	Bothidae	2
203	*Myripristis* spp.	2
203	*Ophichthus* spp.	2
203	*Scartichthys* spp.	2
203	*Synodus lacertinus*	2
203	*Hemicaranx* spp.	2
203	*Pristigenys serrula*	2
203	*Nematistius pectoralis*	2
203	*Ammodytoides gilli*	2
203	*Trachipterus altivelis*	2
203	Chiasmodontidae	2
240	*Atherinella* spp.	1
240	*Vinciguerria* spp.	1
240	Hemiramphidae	1
240	*Argyropelecus sladeni*	1
240	Stomiinae	1
240	*Strongylura exilis*	1
240	*Centrobranchus nigroocellatus*	1
240	*Cheilopogon dorsomaculata*	1

Table 3. (cont.)

Rank	Taxon	Count
240	*Hirundichthys speculiger*	1
240	*Stomias* spp.	1
240	Scaridae	1
240	*Gnathanodon speciosus*	1
240	*Erotelis armiger*	1
240	*Ptereleotris* spp.	1
240	*Dormitator latifrons*	1
240	Triglidae	1
240	*Gobiesox eugrammus*	1
240	*Scorpaena guttata*	1
240	*Labrisomus* spp.	1
240	*Xyrichtys* spp.	1
240	*Cheilodactylus* spp.	1
240	*Abudefduf* spp.	1
240	*Abudefduf troschelii*	1
240	*Abudefduf declivifrons*	1
240	Chaetodontidae	1
240	*Sebastes* spp.	1
240	Bythitidae	1
240	Ogcocephalidae	1
240	*Ceratias holboelli*	1
240	*Zalieutes elater*	1
240	Cynoglossidae	1
240	*Symphurus elongatus*	1
240	Dactyloscopidae	1
240	*Ophioblennius steindachneri*	1
240	*Caristius maderensis*	1
240	*Hypsoblennius brevipinnis*	1
240	*Hypsoblennius proteus*	1
240	*Hypsoblennius gilberti*	1
240	*Hypsoblennius gentilis*	1
240	Blenniidae	1
240	Labrisomidae	1
240	*Perissias taeniopterus*	1
240	Congridae	1
240	*Phtheirichthys lineatus*	1
240	Tetraodontidae	1
240	*Lactoria fornasini*	1
240	*Mola mola*	1
240	*Melamphaes* spp.	1
240	Trichiuridae	1
240	*Paraconger californiensis*	1
240	Apogonidae	1
240	*Evermannella ahlstromi*	1
240	*Lestidiops* spp.	1
240	Paralepididae	1
240	*Scopelengys tristis*	1
240	*Myctophum asperum*	1
240	*Lobianchia gemellarii*	1

Table 3. (cont.)

Rank	Taxon	Count
240	Muraenidae	1
240	*Selene peruviana*	1
240	*Nannobrachium ritteri*	1
240	Bramidae	1
240	Opisthognathidae	1
240	*Psenes* spp.	1
240	*Seriola peruana*	1
240	*Seriola rivoliana*	1
240	*Hemanthias signifer*	1
240	*Elagatis bipinnulatus*	1
240	Priacanthidae	1
240	*Sphyraena* spp.	1
240	*Sphyraena argentea*	1
240	*Pomadasys* spp.	1
240	*Lutjanus novemfasciatus*	1
240	*Howella* spp.	1
240	*Sarda orientalis*	1
240	*Selene* spp.	1
	Total	31508

Table 4. Results of recurrent group analysis of larval fish in Manta net samples from the eastern tropical Pacific,1987–2000. Each taxon is preceded by its taxonomic code and followed by the affinity index and taxa to which it is linked.

POLYDACTYLUS RECURRENT GROUP

561 *Auxis* spp.	HAS 0.464 LINK TO 189
	HAS 0.262 LINK TO 495
	HAS 0.248 LINK TO 481
	HAS 0.219 LINK TO 631
	HAS 0.304 LINK TO 502
189 *Prognichthys* spp.	HAS 0.337 LINK TO 495
	HAS 0.370 LINK TO 481
	HAS 0.256 LINK TO 631
	HAS 0.265 LINK TO 502
495 Gerreidae	HAS 0.365 LINK TO 481
	HAS 0.219 LINK TO 631
	HAS 0.292 LINK TO 502
481 *Mugil* spp.	HAS 0.275 LINK TO 631
	HAS 0.294 LINK TO 502
631 *Polydactylus approximans*	HAS 0.216 LINK TO 502
502 *Caranx caballus*	

POLYDACTYLUS Associates

565 *Euthynnus lineatus*	HAS 0.223 LINK TO 631
418 *Canthidermis maculatus*	HAS 0.205 LINK TO 481
177 *Hemiramphus saltator*	HAS 0.206 LINK TO 481
966 *Symphurus* spp.	HAS 0.222 LINK TO 495
795 Gobiidae	HAS 0.243 LINK TO 495
600 Haemulidae	HAS 0.242 LINK TO 495
513 *Oligoplites* spp.	HAS 0.208 LINK TO 495
33 *Cetengraulis mysticetus*	HAS 0.233 LINK TO 495
580 *Thunnus* spp.	HAS 0.222 LINK TO 561
557 *Coryphaena equiselis*	HAS 0.300 LINK TO 189
	HAS 0.340 LINK TO 561
556 *Coryphaena hippurus*	HAS 0.255 LINK TO 631
	HAS 0.255 LINK TO 481
	HAS 0.270 LINK TO 495
	HAS 0.350 LINK TO 189
	HAS 0.320 LINK TO 561
527 *Cubiceps pauciradiatus*	HAS 0.205 LINK TO 189
	HAS 0.369 LINK TO 561
181 *Oxyporhamphus micropterus*	HAS 0.396 LINK TO 189
	HAS 0.498 LINK TO 561
163 *Cheilopogon xenopterus*	HAS 0.270 LINK TO 189
	HAS 0.230 LINK TO 561
93 *Vinciguerria lucetia*	HAS 0.261 LINK TO 561
16 *Opisthonema* spp.	HAS 0.310 LINK TO 502
	HAS 0.281 LINK TO 481
	HAS 0.488 LINK TO 495
	HAS 0.234 LINK TO 189
	HAS 0.231 LINK TO 561

OXYPORHAMPHUS RECURRENT GROUP

93 *Vinciguerria lucetia*	HAS 0.370 LINK TO 181
	HAS 0.255 LINK TO 557
	HAS 0.265 LINK TO 527
181 *Oxyporhamphus micropterus*	HAS 0.488 LINK TO 557
	HAS 0.363 LINK TO 527
557 *Coryphaena equiselis*	HAS 0.258 LINK TO 527
527 *Cubiceps pauciradiatus*	

OXYPORHAMPHUS Associates

580 *Thunnus* spp.	HAS 0.212 LINK TO 181
556 *Coryphaena hippurus*	HAS 0.216 LINK TO 557
	HAS 0.305 LINK TO 181
187 *Hirundichthys marginatus*	HAS 0.229 LINK TO 557
	HAS 0.238 LINK TO 181
186 *Hirundichthys* spp.	HAS 0.216 LINK TO 181
163 *Cheilopogon xenopterus*	HAS 0.288 LINK TO 557
	HAS 0.320 LINK TO 181
158 *Exocoetus* spp.	HAS 0.219 LINK TO 557
	HAS 0.297 LINK TO 181
323 *Lestidium* spp.	HAS 0.211 LINK TO 93
264 *Lampanyctus parvicauda*	HAS 0.281 LINK TO 93
261 *Lampanyctus* spp.	HAS 0.264 LINK TO 93
76 *Cyclothone* spp.	HAS 0.206 LINK TO 93

OPISTHONEMA RECURRENT GROUP

600 Haemulidae	HAS 0.211 LINK TO 16
	HAS 0.219 LINK TO 610
16 *Opisthonema* spp.	HAS 0.227 LINK TO 610
610 Sciaenidae	

OPISTHONEMA Associates

565 *Euthynnus lineatus*	HAS 0.206 LINK TO 16
217 *Benthosema panamense*	HAS 0.202 LINK TO 16
966 *Symphurus* spp.	HAS 0.210 LINK TO 600
33 *Cetengraulis mysticetus*	HAS 0.226 LINK TO 600

BENTHOSEMA RECURRENT GROUP

795 Gobiidae	HAS 0.211 LINK TO 217
	HAS 0.244 LINK TO 920
217 Benthosema panamense	HAS 0.257 LINK TO 920
920 *Citharichthys platophrys*	

BENTHOSEMA Associates

598 *Trichiurus lepturus*	HAS 0.257 LINK TO 217
966 *Symphurus* spp.	HAS 0.256 LINK TO 795
209 *Synodus evermanni*	HAS 0.200 LINK TO 795
33 *Cetengraulis mysticetus*	HAS 0.373 LINK TO 795

BOTHUS RECURRENT GROUP

359 *Ariosoma gilberti* HAS 0.212 LINK TO 917
917 *Bothus* spp.

SCOMBERESOX RECURRENT GROUP

224 *Ceratoscopelus warmingii* HAS 0.342 LINK TO 191
191 *Scomberesox saurus*

SCOMBERESOX Associates

76 *Cyclothone* spp. HAS 0.291 LINK TO 224

TRIPHOTURUS RECURRENT GROUP

261 *Lampanyctus* spp. HAS 0.250 LINK TO 303
303 *Triphoturus* spp.

TRIPHOTURUS Associates

272 Myctophum aurolaternatum HAS 0.277 LINK TO 261

NEALOTUS RECURRENT GROUP

272 *Myctophum aurolaternatum* HAS 0.221 LINK TO 592
592 *Nealotus tripes*

Table 5. Ten highest ranking larval fish taxa from Manta net catches in each of 11 regions occupied by Marine Mammal Division surveys in the eastern tropical Pacific during 1987 to 2000.

Taxon	Ranking	Average larvae per 100 m^3
Region 1 (89 total samples)		
Total Fish Larvae		52.9
Total Fish Eggs		1528
Auxis spp.	1	14.54
Opisthonema spp.	2	11.52
Oxyporamphus micropterus	3	5.77
Prognichthys spp.	4	4.833
Vinciguerria lucetia	5	1.854
Cetengraulis mysticetus	6	1.82
Polydactylus approximans	7	1.77
Mugil spp.	8	1.401
Cubiceps pauciradiatus	9	1.081
Gerreidae	10	0.93
Region 2 (139 total samples)		
Total Fish Larvae		13.04
Total Fish Eggs		618
Vinciguerria lucetia	1	2.014
Oxyporamphus micropterus	2	1.352
Auxis spp.	3	1.241
Etrumeus teres	4	1.15
Prognichthys spp.	5	0.807
Sardinops sagax	6	0.678
Cubiceps pauciradiatus	7	0.587
Cololabis saira	8	0.445
Scomberesocidae	9	0.391
Mugil spp.	10	0.386
Region 3 (358 total samples)		
Total Fish Larvae		36.42

Total Fish Eggs		537
Opisthonema spp.	1	6.89
Vinciguerria lucetia	2	5.456
Cetengraulis mysticetus	3	5.1
Oxyporamphus micropterus	4	3.974
Auxis spp.	5	2.125
Coryphaena equiselis	6	1.534
Prognichthys spp.	7	1.53
Benthosema panamense	8	1.386
Anchoa spp.	9	1.03
Engraulidae	10	0.787
Region 4 (271 total samples)		
Total Fish Larvae		20.01
Total Fish Eggs		206.8
Vinciguerria lucetia	1	9.65
Oxyporamphus micropterus	2	4.69
Auxis spp.	3	2.603
Opisthonema spp.	4	0.975
Coryphaena equiselis	5	0.897
Cubiceps pauciradiatus	6	0.808
Prognichthys spp.	7	0.581
Hirundichthys marginatus	8	0.2633
Coryphaena hippurus	9	0.2036
Exocoetus spp.	10	0.1957
Region 5 (223 total samples)		
Total Fish Larvae		7.238
Total Fish Eggs		185.4
Vinciguerria lucetia	1	4.863
Oxyporamphus micropterus	2	0.865
Cubiceps pauciradiatus	3	0.438
Coryphaena equiselis	4	0.3902
Auxis spp.	5	0.2943
Lestidium spp.	6	0.182
Howella pammelas	7	0.103
Hirundichthys marginatus	8	0.0767
Cheilopogon xenopterus	9	0.0765

Diaphus spp.	10	0.0743
Region 6 (88 total samples)		
Total Fish Larvae		2.227
Total Fish Eggs		104.1
Vinciguerria lucetia	1	0.689
Coryphaena equiselis	2	0.2905
Oxyporamphus micropterus	3	0.2218
Cheilopogon xenopterus	4	0.132
Hygophum proximum	5	0.117
Lestidium spp.	6	0.0663
Prognichthys spp.	7	0.0558
Naucrates ductor	8	0.0551
Exocoetus spp.	9	0.0367
Ceratoscopelus warmingii	10	0.0335
Region 7 (38 total samples)		
Total Fish Larvae		1.053
Total Fish Eggs		17.08
Vinciguerria lucetia	1	0.251
Coryphaena equiselis	2	0.1687
Anchoa spp.	3	0.134
Cyclothone spp.	4	0.0761
Oxyporamphus micropterus	5	0.0729
Katsuwonus pelamis	6	0.0654
Cheilopogon xenopterus	7	0.0392
Howella pammelas	8	0.0314
Auxis spp.	9	0.0314
Hirundichthys marginatus	10	0.0248
Region 8 (121 total samples)		
Total Fish Larvae		33.02
Total Fish Eggs		643
Vinciguerria lucetia	1	9.11
Scomberesocidae	2	7.43
Engraulidae	3	3.19
Scomber japonicus	4	2.11
Elassichthys adocetus	5	2.05
Scomberesox saurus	6	1.437

Opisthonema spp.	7	0.99
Engraulis ringens	8	0.816
Cetengraulis mysticetus	9	0.604
Sciaenidae	10	0.522
Region 9 (67 total samples)		
Total Fish Larvae		9.67
Total Fish Eggs		196.8
Scomberesocidae	1	3.99
Vinciguerria lucetia	2	3.24
Elassichthys adocetus	3	1.54
Scomberesox saurus	4	0.1073
Cubiceps pauciradiatus	5	0.0553
Cyclothone spp.	6	0.0481
Ceratoscopelus warmingii	7	0.0449
Lampanyctus spp.	8	0.0409
Oxyporamphus micropterus	9	0.0328
Diaphus spp.	10	0.0248
Region 10 (32 total samples)		
Total Fish Larvae		1.156
Total Fish Eggs		461
Vinciguerria lucetia	1	0.381
Scomberesocidae	2	0.1198
Lampanyctus spp.	3	0.056
Cheilopogon pinnatibarbatus	4	0.0557
Auxis spp.	5	0.0557
Howella pammelas	6	0.0534
Coryphaena equiselis	7	0.0337
Vinciguerria spp.	8	0.0336
Ariosoma gilberti	9	0.0302
Coryphaena hippurus	10	0.0297
Region 11 (8 total samples)		
Total Fish Larvae		1.5
Total Fish Eggs		35.5
Exocoetus spp.	1	0.359
Howella pammelas	2	0.276

Syacium ovale	3	0.276
Gigantactis spp.	4	0.138
Auxis spp.	5	0.116
Cubiceps pauciradiatus	6	0.113
Trachipterus altivelis	7	0.111
Coryphaena equiselis	8	0.111
Region 12: all regions combined (1434 total samples)		
Total Fish Larvae		21.99
Total Fish Eggs		437
Vinciguerria lucetia	1	5.231
Opisthonema spp.	2	2.712
Oxyporamphus micropterus	3	2.523
Auxis spp.	4	2.105
Cetengraulis mysticetus	5	1.436
Prognichthys spp.	6	0.876
Scomberesocidae	7	0.855
Coryphaena equiselis	8	0.7285
Cubiceps pauciradiatus	9	0.4998
Engraulidae	10	0.467

Table 6. Eastern tropical Pacific larval fish taxa from Manta net catches and their ranking among the ten most abundant taxa in each of 11 survey regions.

Taxon	Region										
	1	2	3	4	5	6	7	8	9	10	11
Etrumeus teres		4									
Opisthonema spp.	2		1	4				7			
Sardinops sagax		6									
Engraulidae			10					3			
Anchoa spp.			9				3				
Engraulis ringens								8			
Cetengraulis mysticetus	6		3					9			
Cyclothone spp.							4		6		
Vinciguerria spp.								8			
Vinciguerria lucetia	5	1	2	1	1	1	1	1	2	1	
Exocoetus spp.				10		9					1
Cheilopogon xenopterus					9	4	7				
Scombersocidae		9						2	1	2	
Cololabis saira		8									
Elassichthys adocoetus								5	3		
Cheilopogon pinnatibarbatus										4	
Oxyporhamphus micropterus	3	2	4	2	2	3	5		9		
Hirundichthys marginatus				8	8		10				
Prognichthys spp.	4	5	7	7		7					
Scomberesox saurus								6	4		
Benthosema panamense			8								
Ceratoscopelus warmingii						10			7		
Diaphus spp.					10				10		
Hygophum proximum						5					

Table 6. (cont.)

Taxon	Region										
	1	2	3	4	5	6	7	8	9	10	11
Lampanyctus spp.									8	3	
Lestidium spp.					6	6					
Ariosoma gilberti										9	
Trachipterus altivelis											7
Howella pammelus					7		8			6	2
Mugil spp.	8	10									
Gerreidae	10										
Naucrates ductor						8					
Cubiceps pauciradiatus	9	7		6	3				5		6
Coryphaena hippurus				9						10	
Coryphaena equiselis			6	5	4	2	2			7	8
Auxis spp.	1	3	5	3	5		9			5	5
Katsuwonus pelamis							6				
Scomber japonicus								4			
Sciaenidae								10			
Polydactylus approximans	7										
Syacium ovale											3
Gigantactis spp.											4

APPENDIX A

Response to reviewers comments

Reviewers were impressed with the numbers of surface plankton tows taken during the eight surveys and with the amount of work that went into processing and identifying the samples and developing the computer data base. Also, mentioned was the preliminary nature of the analysis of the time series; however, all members recognized that a full analysis will be conducted when the data base for the corresponding oblique tows is completed. They were aware of the importance of the oblique tows in the calibration and interpretation of the surface tows. Reviewers unanimously recommended the reexamination and identification of larval fishes collected on the EASTROPAC Expedition in 1967–68 and recognized the importance of establishing a computer data base for these samples so that larval fish assemblages from the pre-1976 cool regime can be compared with those from the post-1976 warm regime. We have started this and plan to have the EASTROPAC larval fish data available for analysis and comparison with the MOPS-STAR surveys early in 2003. At that time a rigorous analysis of all larval fish samples from the ETP will be carried out. All detailed suggestions made by the reviewers were carefully considered and the report manuscript was amended accordingly.